INSTRUCTION MANUAL

MODEL 146
MULTIFUNCTION
GENERATOR

WAVETEK

WAVETEK SAN DIEGO, INC.

9045 Balboa Ave., San Diego, CA 92123

Serial No. _____

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MODEL 146
MULTIFUNCTION
GENERATOR

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All Wavetek instruments are warranteed against defects in material and workmanship for a period of one year after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during this period. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which in Wavetek's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

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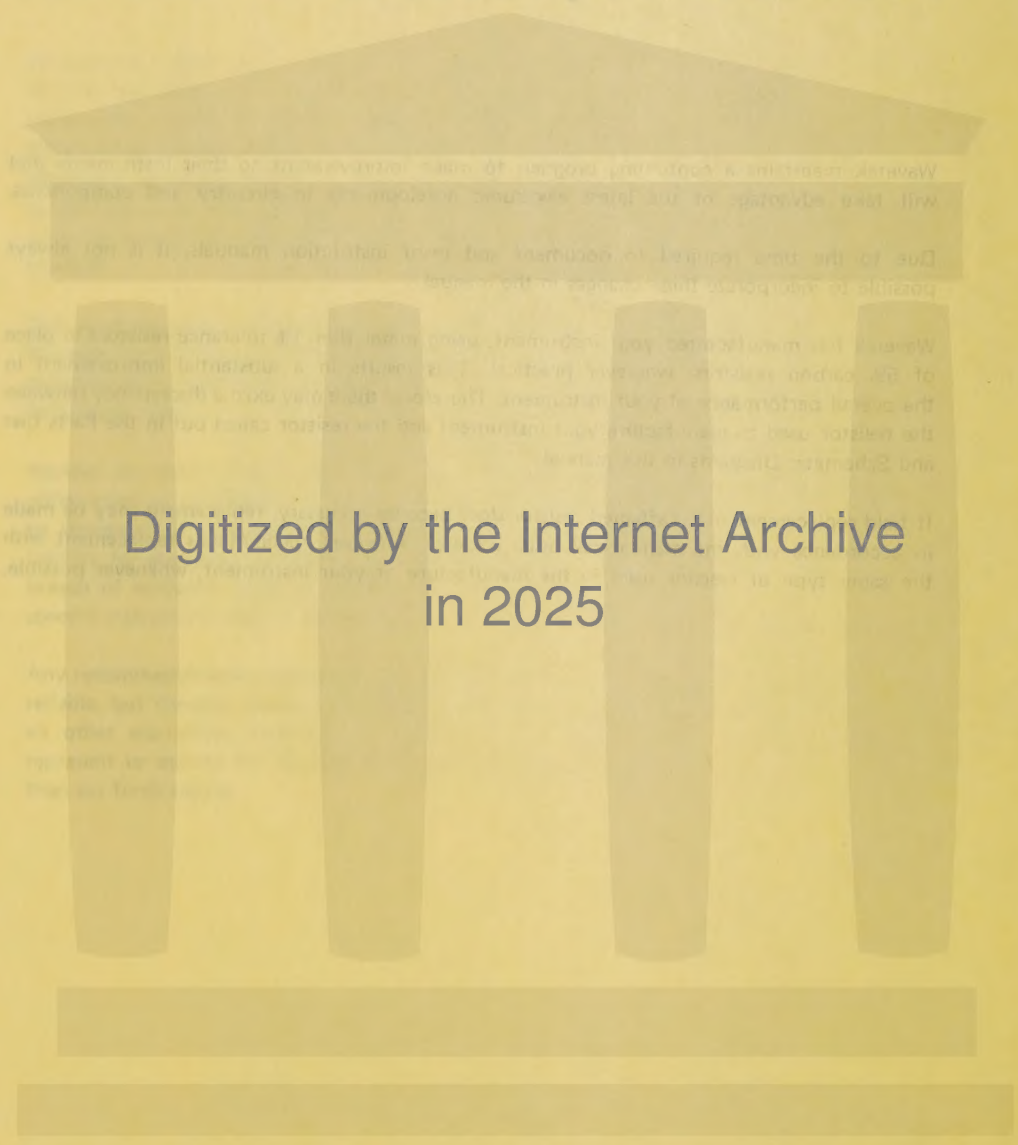
Product Improvement Notice

Wavetek maintains a continuing program to make improvements to their instruments that will take advantage of the latest electronic developments in circuitry and components.

Due to the time required to document and print instruction manuals, it is not always possible to incorporate these changes in the manual.

Wavetek has manufactured your instrument, using metal film 1% tolerance resistors in place of 5% carbon resistors, wherever practical. This results in a substantial improvement in the overall performance of your instrument. Therefore, there may exist a discrepancy between the resistor used to manufacture your instrument and the resistor called out in the Parts List and Schematic Diagrams in this manual.

If field replacement of an affected resistor does become necessary, replacement may be made in accordance with the manual call outs. Wavetek, however, recommends replacement with the same type of resistor used in the manufacture of your instrument, whenever possible.



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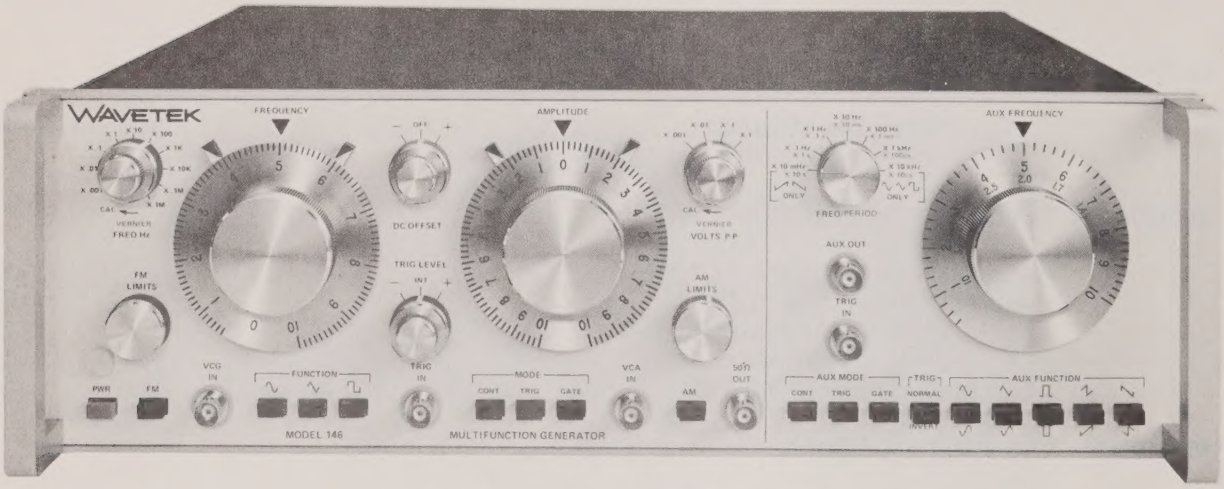

Figure i — Model 146 Multifunction Generator

SCOPE OF THIS MANUAL

This manual provides descriptive material and instructions for the installation, operation, maintenance, and repair of this instrument. Wavetek's product improvement program ensures that the latest electronic developments are incorporated in all Wavetek instruments by the addition of circuit and component changes as rapidly as development and testing permit. Due to the time required to document and print instruction manuals, it is not always possible to incorporate the more recent changes in the released manual. In this case, data will be found on addendum change page(s) at the back of the manual.

We continue to rely on careful readers to help us improve future revisions of this instruction manual. If you should spot an error, inconsistency, or ambiguity, send your corrections and comments to:

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SECTION 1
INTRODUCTION

1.1 GENERAL CAPABILITIES

The Model 146 Multifunction Generator consists of two independent signal sources in one integrated unit. Each generator can be used as an individual signal source, or both can be used together. Functions and operating modes of both generators are push button selectable. The signal of the main generator can be frequency or amplitude modulated by any of the auxiliary generator waveforms. Analog control of output frequency and amplitude is provided by VCG (Voltage Controlled Generator) and VCA (Voltage Control of Amplitude) circuitry. Amplitude is variable from maximum through null to maximum at inverted phase. A caliper dial establishes upper and lower limits for frequency and amplitude modulation. Continuous, triggered and gated waveforms can be produced by the main generator through the range of 0.0005 Hz to 10 MHz. The auxiliary generator is capable of producing sine, square, triangle, and special sawtooth outputs. These waveforms can be internally applied to the main generator to obtain frequency modulation and frequency sweep up to 1000:1 ratio; amplitude modulation through 100% to suppressed carrier modulation; and triggered, gated and tone burst outputs. Operating range of the auxiliary generator is 0.004 Hz to 100 kHz. Both generators can be externally triggered. VCG and VCA connectors are available for external inputs to the main generator. Auxiliary and main generator output impedances are 600Ω and 50Ω, respectively.

1.2 PHYSICAL AND ELECTRICAL SPECIFICATIONS

MAIN GENERATOR

1.2.1 Versatility

Waveforms
Selectable sine ∿ , square ⊓ , and triangle △ and dc outputs. Symmetry of all outputs continuously adjustable from 1:19 to 19:1, with rear panel control. Varying triangle symmetry provides a positive slope sawtooth ◿ , or negative slope sawtooth ◺ output. Separate sync with variable symmetry (see below). Waveform can be continuous, triggered, or gated.

Frequency Range
0.0005 Hz to 10 MHz in 10 decade ranges.

Ranges

X 0.001	0.0005 Hz to 0.01 Hz
X 0.01	0.005 Hz to 0.1 Hz
X 0.1	0.05 Hz to 1 Hz
X 1	0.1 Hz to 10 Hz
X 10	1 Hz to 100 Hz
X 100	10 Hz to 1 kHz
X 1K	100 Hz to 10 kHz
X 10K	1 kHz to 100 kHz
X 100K	10 kHz to 1 MHz
X 1M	100 kHz to 10 MHz

NOTE

When symmetry control is used, indicated frequency is divided by a factor of approximately 10.

Main Output
Sine, square, and triangle selectable. Maximum output 20 V p-p open circuit and 10 V p-p into 50Ω. Precision front dial controls the amplitude with high resolution and provides phase reversal of output. Output impedance is 50Ω. Short circuit current is 150 mA. Precision output range multiplier with four decade steps.

Sync Output
Amplitude greater than 4 V p-p into open circuit; 2 V p-p into 50Ω. Rise and fall times are less than 50 nanoseconds. Square waveform for symmetrical outputs; rectangular waveform for non-symmetrical outputs.

DC Offset
Can be controlled manually using the front panel control. Range of ±10 Vdc into open circuit (±5 Vdc into 50Ω load), peak output limited to ±15 Vdc into open circuit (±7.5 Vdc into 50Ω load). DC offset and output waveform are attenuated proportionately by the amplitude range multiplier.

Operating Modes
Continuous, triggered, and gated modes of the main and auxiliary generator are push button selectable. Triggering or gating of the main generator by the auxiliary generator is internal. The auxiliary generator may be triggered or gated by the main generator through external connections on the rear panel. Both generators provide for external triggering and gating.

SECTION 2
INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to switches, connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packaging material should be retained in case reshipment is required.

A Wavetek Rack Adapter Kit will allow this unit to be mounted in a standard 19-inch equipment rack. No mechanical installation is required when the instrument is to be used as a portable bench unit.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

NOTE

Unless otherwise specified at the time of purchase, all Wavetek Model 146 instruments are shipped from the factory with the power transformer connected for operation on a normal 115-volt ac line supply, and a 1/2 ampere 115-volt slow-blow line fuse.

CAUTION

To convert to 230 volts, set the slide switch at the rear of the instrument to 230, and replace the fuse with a slow-blow fuse rated at 1/4 ampere at 230 volts. Connect the ac line cord to the mating connecter at the rear of the unit.

2.2.2 Signal Connections

Use 50Ω shielded cables equipped with female BNC connectors to distribute all RF signals when connecting this instrument to associated equipment.

2.3 OPERATING CONTROLS

The operating controls and electrical connections for the Model 146 are shown in Figures 2-1 and 2-2. Each of the following paragraph numbers corresponds to a number appearing in Figure 2-1, front panel, and Figure 2-2, rear panel.

FRONT PANEL CONTROLS

1. **FREQ Hz** — Selects one of ten decade ranges from X 0.001 to X 1M to establish the frequency multiplier for main generator frequency.

2. **Frequency VERNIER** — Allows precision control of the output frequency. A complete turn of this control is approximately equal to 1% of full scale on the FREQUENCY dial. When turned to the full clockwise position (CAL), settings on the main dial will be calibrated.

3. **FREQUENCY Dial (Main)** — Controls the frequency of the main generator. The setting on this dial multiplied by the frequency range setting (1) equals the output frequency of the generator. The frequency VERNIER (2) and the SYMMETRY ADJUST (39) (rear panel) also affect the generator frequency.

4. **FREQUENCY Index (Main)** — The lower point of the triangle above the FREQUENCY dial indicates the dial setting.

5. **Caliper Pointers (FM)** — Indicate the limits for frequency sweep or modulation on the FREQUENCY dial (3).

6. **DC OFFSET Control** — Controls the amount of dc or baseline offset above (+) or below (—) signal ground. The larger knob controls the polarity of dc offset and the smaller knob adjusts the baseline offset ±10 Vdc into an open circuit (±5 Vdc into 50Ω load), with peak output limited to ±15 Vdc into an open circuit (±7.5 Vdc into 50Ω load).

7. **AMPLITUDE Dial** — Allows calibrated control of amplitude for the main generator output. This control is bipolar; that is, as the dial is rotated from the full cw to full ccw, the output waveform will be

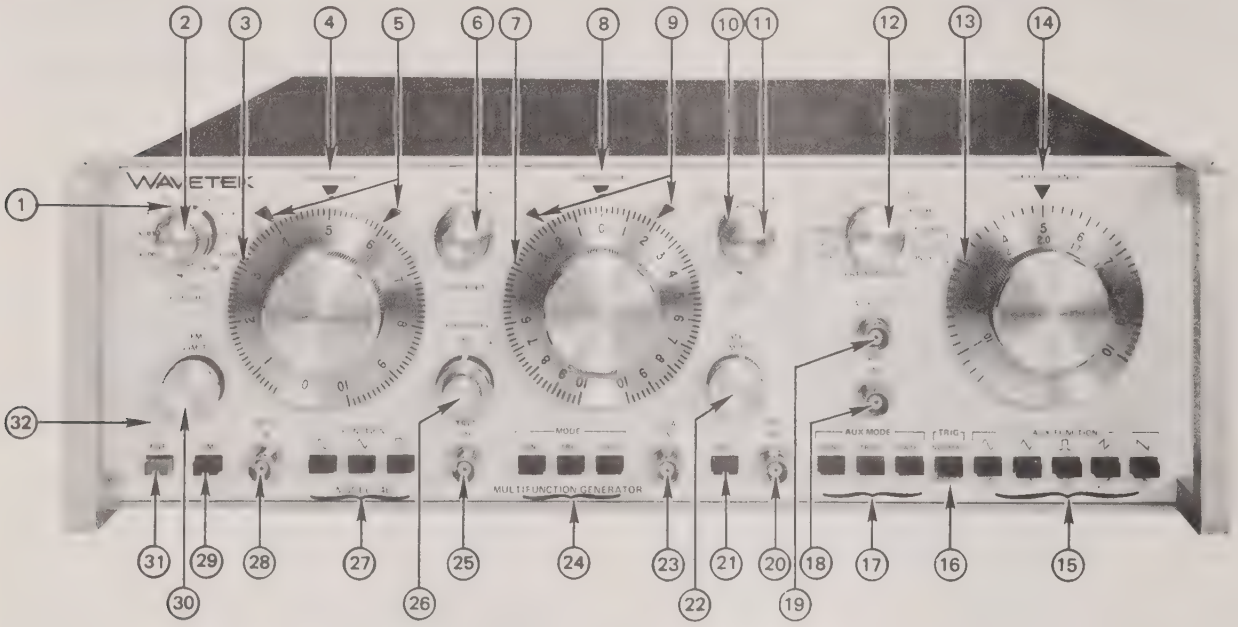


Figure 2-1. Operating Controls and Electrical Connections, Front Panel

phase shifted 180° as the dial passes through zero. This setting multiplied by the VOLTS P-P (10) setting and VERNIER (11) adjustment equals the main generator output amplitude.

8. **AMPLITUDE Index** – The lower point of the triangle above the AMPLITUDE dial indicates the dial setting.

9. **Caliper Pointers (AM)** – Indicate the limits for amplitude modulation on the AMPLITUDE dial (7).

10. **VOLTS P-P** – Attenuates the main generator output signal in four calibrated steps, X 1, X 0.1, X 0.01 and X 0.001.

11. **VOLTS P-P VERNIER** – Allows precision control over the output amplitude. A complete turn of this vernier is equivalent to approximately 5% of the AMPLITUDE dial (7) setting multiplied by the VOLTS P-P (10) selector setting. When in the full cw position (CAL), the setting on the AMPLITUDE dial (7) will be calibrated.

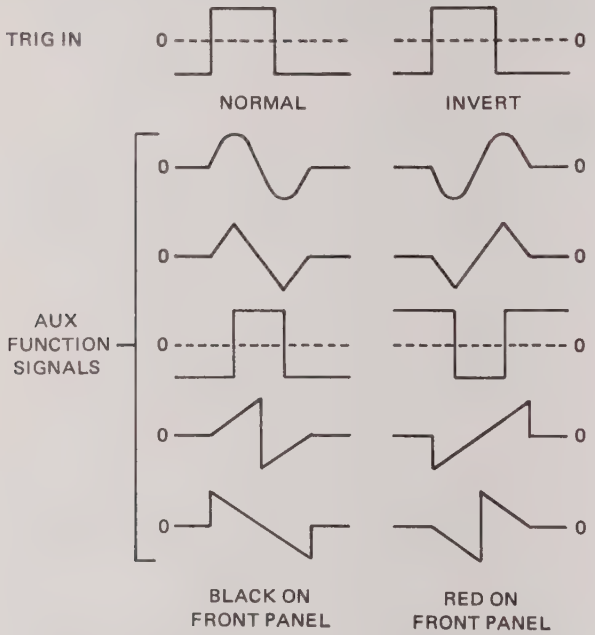
12. **FREQ/PERIOD** – Selects one of seven decade ranges from X 10 mHz to X 10 kHz (black numerals and letters) for auxiliary generator frequency. However, the X 10 mHz setting can only be used when the positive or negative slope sawtooth waveform ⟋ ⟍ is selected. The X 10 kHz setting can only be used when the sine ∿ , triangle ∿ , or square ⊓ (15) waveform is selected. The selected frequency range and black AUX FREQUENCY dial setting (13) determine the output frequency of the auxiliary generator. The dial and range multiplier are also calibrated in period for convenience. This calibration is indicated in red.

13. **AUX FREQUENCY Dial** – Controls the frequency of the auxiliary generator. The outer scale setting (black on this dial) multiplied by the selected frequency range (12) equal the output frequency of the auxiliary generator. The inner scale setting (red on this dial) multiplied by the selected period setting (12) gives the auxiliary generator period.

14. **AUX FREQUENCY Index** – The lower point of the triangle above the AUX FREQUENCY dial indicates the dial setting.

15. **AUX FUNCTION Selector** – Allows push button selection of the waveform to appear at the AUX OUT (19) connector. The waveforms are sine ∿ , triangle ∿ , square ⊓ , sawtooth ⟋ , and negative slope sawtooth ⟍ for normal functions. These waveforms appear in black above the push buttons. When the AUX MODE – TRIG or GATE push button is in the depressed position and the TRIG push button is in the depressed (INVERT) position, depressing one of the AUX FUNCTION push buttons will select the waveform appearing in red below the push button.

16. **TRIG** — Selects the state of the step source which controls the direction of integration when enabled by the TRIG IN signal (18). In the NORMAL (released) position, the auxiliary generator will start integrating positively and in the INVERT (depressed) position, it will start integrating negatively. This switch is only effective in the TRIG (17) or GATE (17) auxiliary mode. (Refer to the following illustration.)



17. **AUX MODE Selector**

CONT (Continuous Mode) — Allows continuous wave operation of the auxiliary generator at the selected frequency.

TRIG (Trigger Mode) — Allows the auxiliary generator to produce one complete cycle of output for each square wave pulse applied to the TRIG IN connector (18).

GATE (Gated Mode) — Operates the same as trigger mode, except that the auxiliary generator will continue to produce an output for the full time that the signal at the TRIG IN connector (18) exceeds the minimum gating level (approximately +2 volts). When the gating signal is removed, the generator will complete the last cycle.

18. **TRIG IN** — Provides a dc coupled input with 3 kΩ input impedance, when in the GATE mode (17). The minimum gating level (signal at TRIG IN connector) is +2 volts. When in the TRIG mode (17), the TRIG IN connector is ac coupled and requires a minimum input square wave of 4 volts peak to peak and 1 microsecond in width. Maximum external input level is 30 volts peak for both modes.

19. **AUX OUT** — Provides approximately 600Ω output impedance connection for all auxiliary generator output functions. The output amplitude is ±2.5 volts into an open circuit.

20. **50Ω OUT** — Provides 50Ω output impedance connection for all main generator output signals.

21. **AM** — When depressed, this push button enables amplitude modulation of the main generator signal by the waveform selected in the auxiliary generator. The frequency of the modulation envelope is determined by the auxiliary generator.

22. **AM LIMITS** — Opens the AM caliper pointers when turned in the cw direction and closes the pointers when turned in the ccw direction to set the amplitude modulation limits. The AM push button must be depressed to enable the caliper pointers to set the calibrated limits.

23. **VCA IN** — Provides connections for an external input signal up to ±5 volts for amplitude modulation of the main generator signal. Input impedance is 10 kΩ.

24. **MODE Selector**

CONT (Continuous Mode) — Provides continuous wave operation of the main generator at a fixed frequency.

TRIG (Trigger Mode) — Allows the main generator to produce one complete cycle of output for each pulse applied to the TRIG IN connector (25). Manual triggering can be accomplished by rotating the TRIG LEVEL control (26) from full ccw to full cw position with the TRIG LEVEL switch (26) in the positive (+) position. At higher generator frequencies, triggering with this manual control will be difficult. Use an external trigger.

GATE (Gated Mode) — Operates the same as trigger mode, except that the main generator will continue to produce an output for the full time that the signal at the TRIG IN connector (25) exceeds the minimum gating level (approximately +2 volts).

25. **TRIG IN** — Provides connection for an external trigger or gating signal to the main generator when the TRIG or GATE (24) push button is in the depressed position. The trigger signal should be at least ±3 volts dependent upon the position of the TRIG LEVEL switch (26). Maximum external input level is ±50 volts peak.

26. **TRIG LEVEL Selector and Control** – When the selector (larger knob) is set to the INT position, the main generator is triggered internally by the auxiliary generator. In the INT position, the TRIG LEVEL control adjusts the sensitivity of the trigger input circuitry, + (ccw) and – (cw). When an external trigger is used, the TRIG LEVEL selector must be set to the – or + position for selection of the respective negative or positive portion of the trigger signal. When the control is in the full cw position, approximately –15 volts is required for triggering. In the full ccw position, approximately +15 volts is required for triggering. At the midpoint, extremely low voltages will trigger the main generator.

27. **FUNCTION Selector** – Allows push button selection of the waveform to appear at the 50Ω OUT (20) connector. The waveforms are sine ∿ , triangle ∿ , and square ⊓ .

28. **VCG IN (Voltage Controlled Generator Input)** – Allows external control of frequency. With 0 voltage in, the generator output frequency is determined by the frequency range selected and the FREQUENCY dial setting. A positive VCG voltage will increase the frequency, and a negative voltage will decrease the frequency within the limitations described in 2.5.2. Input impedance is 5 kΩ.

29. **FM Switch** – Allows the main generator to be frequency modulated by the auxiliary generator when in the depressed position. The FM LIMITS (30) determines the amount of sweep or modulation.

30. **FM LIMITS** – Opens the FM caliper pointers when turned in the cw direction and closes the pointers when turned in the ccw direction to set the frequency sweep or modulation limits. The FM push button must be depressed to enable the caliper pointers to set the calibrated limits.

31. **PWR** – Applies power to the unit when push button is in the depressed position.

32. **Power Indicator** – Illuminates when the unit has been switched on.

REAR PANEL CONTROLS

33. **FUSE** – Protects the instrument from ac line transients as well as short circuits within the instrument. For 115 Vac operation, use a 1/2 ampere slow-blow fuse. For 230 Vac operation, use a 1/4 ampere slow-blow fuse.

34. **Power Receptacle** – Accepts a female power connector for applying 115 or 230 volts ac.

35. **115 – 230 Volt Switch** – Selects the power input voltage used. The instrument is normally shipped for 115 Vac and a 1/2 ampere fuse. To convert to 230 Vac, set slide switch to 230 and install a 1/4 ampere slow-blow fuse.

36. **AUX SYNC OUT** – Provides a synchronizing waveform at the same frequency as the auxiliary generator. The maximum output amplitude is 5 volts peak to peak into an open circuit.

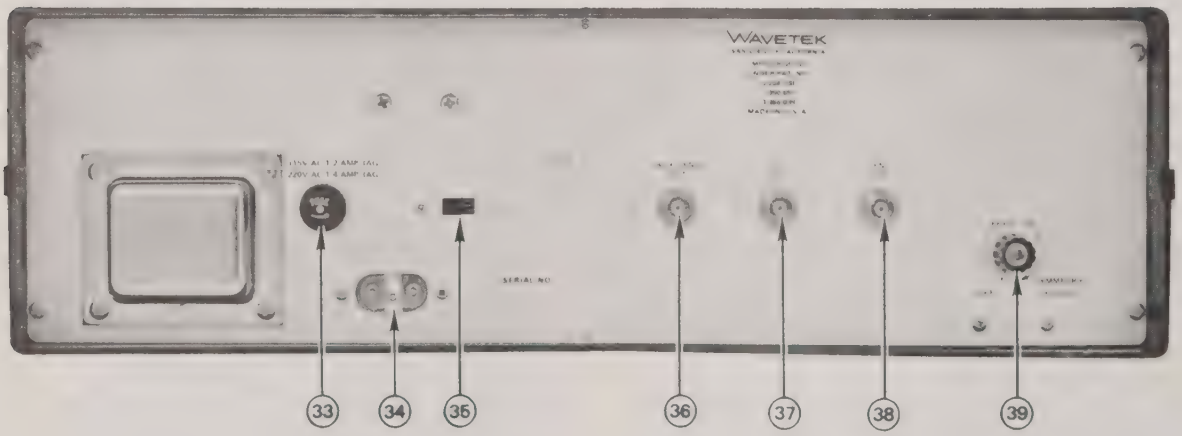


Figure 2-2. Operating Controls and Electrical Connections, Rear Panel

37. **GCV OUT** – Provides an analog voltage which is proportional to the output frequency of the main generator. This output is changed when the main generator FREQUENCY dial (3) is turned; a signal is applied to the VCG IN (28) connector; or the auxiliary generator is connected for frequency modulation of the main generator signal.

38. **SYNC OUT** – Provides a square or rectangular output at the same frequency as the main generator. The output amplitude is approximately 4 volts peak to peak into 50Ω impedance.

39. **SYMMETRY ADJUST** – Controls the time symmetry between the positive and negative portions of the output waveform. In the full ccw detented (OFF) position, the control is disabled and the output waveform has 1:1 symmetry (50% duty cycle). Rotating the control in a cw direction will release the calibrated detent and cause the frequency to divide by approximately 10. Continuing in a cw direction will vary the time symmetry from 1:19 through 19:1. This allows a minimum pulse width of approximately 50 nanoseconds with a repetition rate of 1 MHz.

2.4 INSTALLATION CHECKS

This paragraph outlines a quick checkout procedure to determine if the instrument is operating correctly. Field calibration and checkout instructions are given in Section 4 to determine compliance with electrical specifications. If electrical deficiencies exist, refer to the warranty on the back of the title page. Use an oscilloscope and counter-timer of the type stated in Table 4-1 when performing these installation checks.

1. Set front and rear panel switches and controls as follows (refer to Section 2.3 for location of controls):

SWITCH/CONTROL	POSITION/ROTATION
MAIN GENERATOR	
FREQ Hz	X 10
Frequency VERNIER	cw
FREQUENCY Dial	10
FM	out
FUNCTION	∿
DC OFFSET Switch	OFF
DC OFFSET Control	ccw
TRIG LEVEL Switch	INT
TRIG LEVEL Control	ccw
MODE	CONT
AMPLITUDE Dial	ccw at 10
VOLTS P-P	X 1
VOLTS P-P VERNIER	cw
AM	out
AUXILIARY GENERATOR	
FREQ/PERIOD	X 100 Hz/X 1 ms
FREQUENCY Dial	10
AUX MODE	CONT
TRIG	NORMAL (out)
AUX FUNCTION	∿

2. Depress PWR push button and check to assure indicator is illuminated.

3. Connect AUX OUT to oscilloscope. Check to assure waveform displayed is 5 V p-p open circuit (approximately 2.5 V p-p terminated into a 600Ω load) at 1 kHz.

4. Connect a BNC cable between auxiliary generator TRIG IN connector and main generator SYNC OUT (rear panel). Depress AUX MODE – TRIG push button. Check oscilloscope display to assure one cycle of selected waveform appears and is identical to waveform *above* selected function push button.

5. Depress TRIG (NORMAL/INVERT) push button. Check oscilloscope display to assure waveforms appear identical to waveform *below* selected function push button.

6. Depress AUX MODE – GATE push button. Check oscilloscope display to assure several cycles of selected waveform appear.

7. Depress AUX MODE – CONT push button.

8. Rotate AUX FREQUENCY generator dial cw to the 1 setting, while observing oscilloscope display. Sine wave frequency should change from 1 kHz to 100 Hz. Check range-to-range tracking accuracy with dial setting at 10.

NOTE

∿ , ∿ , and ⎍ functions will not operate on lowest range, X 10 mHz.

9. Depress AUX FUNCTION – ⟋ push button.

10. Check range-to-range tracking accuracy with dial setting at 10.

NOTE

⟋ and ⟍ functions will not operate on highest range, X 10 kHz.

11. Check remaining AUX FUNCTION selections for correct waveforms.

12. Connect AUX SYNC OUT connector (rear panel) to oscilloscope. Waveform display should be a 5 V p-p square wave for ∿ , ∿ , and ⎍ functions and 5 V p-p rectangular wave for ⟋ and ⟍ functions.

13. Set FREQ Hz switch to X 100 position.

14. Connect oscilloscope Trigger In Connector to instrument SYNC OUT connector (rear panel).

15. Connect 50Ω OUT connector to oscilloscope with 50 ohm terminator. Waveform should be 1 kHz sine wave at 10 V p-p. Rotate AMPLITUDE dial cw. Amplitude should decrease to zero when dial setting reaches 0 and should increase to 10 V p-p, 180° out-of-phase, at full cw setting.

16. Turn AMPLITUDE dial to 0; depress AUX FUNCTION ⎍ push button; and connect a BNC cable from AUX OUT connector to VCA IN connector. Check to assure amplitude of oscilloscope display is approximately 5 V p-p and symmetrical about ground.

17. Set DC OFFSET switch to – position. DC OFFSET control should vary waveform reference from 0 to at least –5 volts.

18. Set DC OFFSET switch to + position. DC OFFSET control should vary waveform reference from 0 to at least +5 volts.

19. Disconnect BNC cable from AUX OUT and VCA IN connector.

20. Set DC OFFSET switch to OFF position; depress AM push button; and turn AM LIMITS control until caliper pointers are on both 5s of AMPLITUDE dial. Check to assure amplitude of oscilloscope display is approximately 5 V p-p and symmetrical about ground.

21. Turn AMPLITUDE dial to either 10 (caliper pointers together); release AM switch; depress AUX MODE – CONT push button; depress MODE – TRIG push button; depress AUX FUNCTION – ∿ push button; set FREQ Hz to X 1K position; set FREQ/PERIOD switch to X 100 Hz position; and adjust Trigger Level Control until one cycle of selected waveform appears in oscilloscope display.

22. Depress MODE – GATE push button. Check oscilloscope display to assure multiple cycles of selected waveform appear when Trigger Level Control is rotated toward the cw extreme and disappear when the control is turned toward the ccw extreme.

23. Set TRIG LEVEL switch to negative (–) position. Connect BNC connector from AUX OUT connector to main generator TRIG IN connector. Check to assure multiple burst of cycles of selected waveform appears in oscilloscope display when the Trigger Level Control is rotated toward the cw extreme and disappears when the control is turned toward the ccw extreme.

24. Set TRIG LEVEL switch to positive (+) position. Check to assure multiple burst of cycles of selected waveform appears in oscilloscope display, when the Trigger Level Control is rotated toward the ccw extreme and that the generator free-runs when the control is turned toward the cw extreme.

25. Depress MODE – CONT push button; set TRIG LEVEL switch to INT position; turn Trigger Level Control fully ccw; and depress FUNCTION – ⎍ push button. Check to assure oscilloscope display is ⎍ waveform, 10 V p-p at 10 kHz.

26. Move VOLTS P-P switch to each position while checking oscilloscope display to assure correct attenuation at each position. Return VOLTS P-P switch to X 1 position.

27. Rotate VOLTS P-P VERNIER control to assure approximately 5% change of amplitude reading. Return control to CAL position.

28. Rotate FREQUENCY dial cw to the 1 setting, while observing oscilloscope display to assure square wave frequency changes from 10 kHz to 1 kHz. Check range-to-range tracking accuracy with dial setting at 10.

29. Rotate FREQ Hz VERNIER control to assure approximately 1% change in full scale frequency and return to CAL position.

30. Set FREQ Hz switch to X 10K position. Rotate SYMMETRY ADJUST control (rear panel) slightly cw until detent is disengaged. Check oscilloscope display to assure square waveform is unsymmetrical by a ratio of approximately 1:19 and the frequency is divided by approximately 10. Continue rotating the SYMMETRY ADJUST control through its entire range. Symmetry of the square waveform should vary from 1:19 through 1:1 to 19:1 at the full cw extreme.

31. Rotate SYMMETRY ADJUST control ccw to OFF position; set FREQUENCY dial to 0; set FREQ Hz to 1K position; depress AUX MODE – TRIG push button; depress AUX FUNCTION – ⎍ push button; depress TRIG push button to INVERT; and connect BNC cable between AUX OUT connector and VCG IN connector. Check to assure square waveform frequency in oscilloscope display is approximately 5 kHz.

32. Remove cable from AUX OUT and VCG IN connectors; turn FM LIMITS control cw; and depress FM push button. Check to assure square waveform frequency in oscilloscope display is approximately 10 kHz. Return FM push button to out position.

33. Connect oscilloscope to SYNC OUT connector. Check to assure square waveform in oscilloscope display is 4 V p-p (2 V p-p into 50 ohm load).

34. Connect oscilloscope to GCV OUT connector (rear panel). Rotate main generator FREQUENCY dial from fully cw to fully ccw. Check oscilloscope display to assure voltage level varies from 0 to +5 volts.

2.5 OPERATING PROCEDURE

No preparation for operation is required beyond completion of the initial installation checks given in Paragraph 2.4 of this manual. It is recommended that a one-half hour warm-up period be allowed for the associated equipment to reach a stabilized operating temperature and for the Model 146 to attain stated accuracies.

2.5.1 Operation as a Function Generator

MAIN GENERATOR

1. Terminate 50Ω OUT connector with 50 ohm ±1% termination.

2. Select desired waveform and mode of operation by depressing respective FUNCTION and MODE push buttons.

3. Set desired output frequency by setting the FREQUENCY dial and FREQ Hz range multiplier to the respective positions.

4. Select desired amplitude of output by setting the AMPLITUDE dial and VOLTS P-P multiplier to the respective positions.

5. Select the polarity of dc offset desired using the DC OFFSET switch, and set the amount of offset using the VERNIER control. If an excessive amount of dc offset is used, waveform clipping may be observed. The sum of peak waveform voltage and dc offset cannot exceed the maximum rated output of the main generator. Maximum output is 15 V peak to peak or 7.5 V peak above and below 0 volts. Offset plus peak voltage cannot exceed 7.5 V. (See Figure 2-3.)

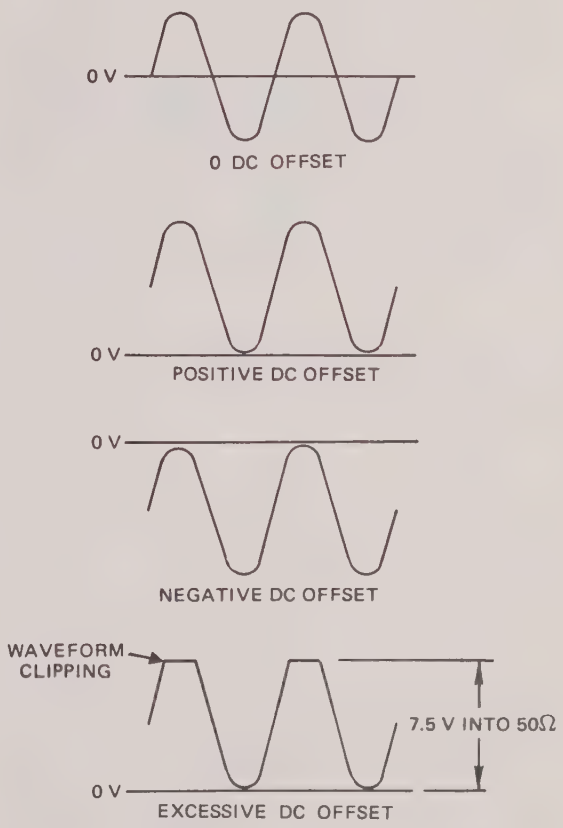


Figure 2-3. DC Offset Control

6. Set SYMMETRY ADJUST control for desired symmetry or dissymmetry. The symmetry control can be used to develop ramp waveforms with variable rise-fall ratios and pulse trains with variable duty cycle. By using the sine wave with dissymmetry, controllable sine distortion can be developed. Figure 2-4 shows the effect of this control on output waveforms.

AUXILIARY GENERATOR

1. Connect oscilloscope to AUX OUT connector (600 ohm output impedance).

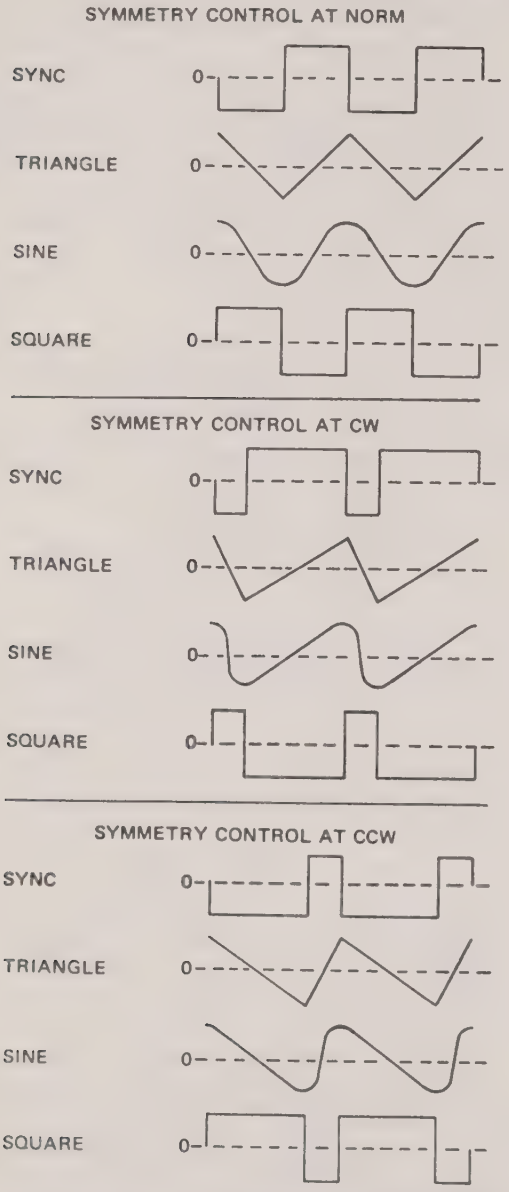


Figure 2-4. Waveform Phasing and Symmetry Control

2. Select desired waveform and mode of operation by depressing respective AUX FUNCTION and AUX MODE push buttons.

3. Set desired output frequency by setting FREQUENCY dial and FREQ/PERIOD range multiplier.

4. Output signal should be 5 volts p-p into an open circuit, or 2.5 volts p-p into 600 ohms.

2.5.2 Operation as a Frequency Modulated, Sweep or Voltage Controlled Generator

The frequency of the Model 146 may be modulated or changed in several ways as follows:

1. Modulated around a center frequency.

2. Swept from a low to a high frequency or a high to a low frequency.

3. Frequency Shift Keyed (FSK).

These and other types of frequency modulation may be performed internally or externally. The auxiliary generator provides the waveforms for the internal FM and the VCG IN connector allows an external signal to be used for FM.

Using the internal method of FM allows calibrating the limits of the modulation using the FM LIMITS control. This control spreads the caliper pointers to the desired calibrated limits.

The principle of operation is simple. An increasing voltage causes the frequency to increase and a decreasing voltage causes the frequency to decrease. Therefore, the type of frequency modulation depends only on the waveform used to FM. The following waveforms as selected from the auxiliary generator provide the indicated modulations:

∿

A sine wave input will cause the main generator to FM around the center frequency (f_c) by an amount of $\triangle f$ (f_m). The f_c is the frequency as read off the main dial under the top index. The f_m is the value as read adjacent to the caliper pointers on the main dial if internal modulation is used. If external modulation is applied to the VCG IN connector, the amount of deviation, $\triangle f$, may be approximated using the voltage-to-frequency nomograph shown in Figure 2-5, or may be measured using a counter.

⎍

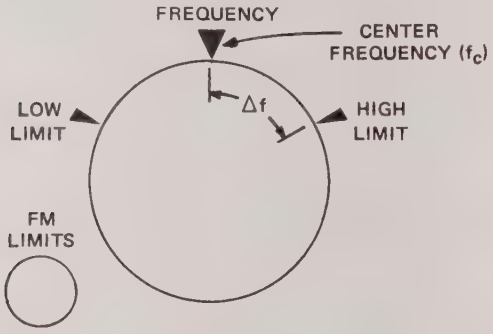
A square wave, or other dc shift, will cause Frequency Shift Keying (FSK). The frequency will instantaneously change to the two values as set by the pointers if internal modulation is used or as determined using the nomograph in Figure 2-5, if an external signal is applied to the VCG IN connector.

A positive sloped ramp will cause the main generator frequency to be swept from a low to a high value. If the internal auxiliary generator is used, these low and high limits may be set by rotating the FM LIMITS control in conjunction with the main FREQUENCY dial to achieve the desired *calibrated* end points of the sweep. The sweep limits are read off the main FREQUENCY dial adjacent to the pointers.

A negative sloped ramp will sweep the generator from a high to a low frequency in the same manner as described above.

INTERNAL FM

Using the internal method of frequency modulating is straightforward since the limits are calibrated. Note the following diagram.



The following is a step-by-step procedure for internal FM:

1. Set the main FREQUENCY dial in conjunction with the FM LIMITS control to the limits required by the application. Up to 1000:1 frequency deviation is allowed. The mechanical stops disallow incorrect settings.

2. Select the waveform which is to be modulated by depressing the appropriate FUNCTION push button on the main generator.

3. Depress MODE — CONT push button on the main generator.

4. Set the AMPLITUDE dial to the desired output level.

5. Set the AUX FREQUENCY dial to the desired rate of modulation.

6. Select the desired modulating waveform by depressing one of the AUX FUNCTION push buttons.

7. Select the desired AUX MODE.

8. Depress the FM push button on the main generator.

EXTERNAL FM

The VCG IN connector can be used to externally control the frequency of the main generator.

NOTE

When using an external voltage to FM, the FM LIMITS control has no affect.

The nomograph in Figure 2-5 may be used to determine the FM limits. If a positive voltage is applied to the VCG IN connector, the frequency will increase from the FREQUENCY dial setting. A negative voltage will cause the frequency to decrease. The VCG range of the Model 146 is 1000:1 on and FREQ Hz selector setting. With external voltage control the frequency can be driven to 0 in any range, but below 1/1000th of full scale, stability is insufficient for practical control.

The nomograph in Figure 2-5 shows the characteristics of the VCG circuit. Column A gives the FREQUENCY dial setting, column B, the VCG voltage and column C, the resultant frequency.

In Example 1, the FREQUENCY dial setting is 5 and the potential at the VCG IN connector is 0 volts. Extend a straight line from 5 (FREQUENCY dial setting) through 0 volts (VCG voltage). The result is an output frequency of 5 (multiplied by the FREQ Hz selector setting).

In Example 2, the FREQUENCY dial setting is 5 and a varying voltage of −1 volt to +1 volt is applied to the VCG IN connector. Extend a straight line from 5 (FREQUENCY dial setting) through −1 volt and another through +1 volt (VCG voltage). The result is an output frequency that will vary from 3 to 7 (multiplied by the FREQ Hz selector setting).

To obtain a maximum frequency change of 1000:1, such as sweeping from 10 kHz to 10 MHz, proceed as follows:

1. Connect a counter, or oscilloscope, to the 50Ω OUT connector.

2. Set the FREQ Hz selector to the X 1M position.

3. Turn the FREQUENCY dial cw to a frequency equal to 0.1 of full scale (100:1).

4. Rotate the frequency VERNIER control ccw to reduce the frequency another 10:1, thereby providing a fre-

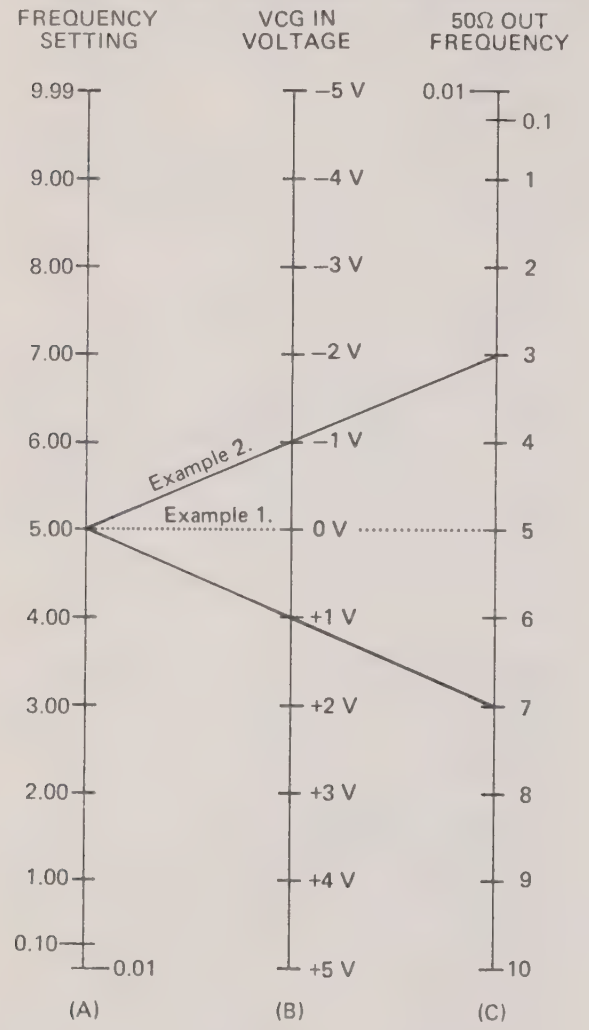


Figure 2-5. VCG Voltage-to-Frequency Nomograph

quency equal to 0.01 of full scale, 10 kHz (0.01 X 1M = 10 kHz).

5. Connect a 0 to +5 volt ramp signal to the VCG IN connector.

6. Observe that when the VCG signal increases to +5 volts, the output will have increased to a frequency equal to full scale (10 MHz), or 1000 times.

As another example, sweep down from 1 kHz to 1 Hz. The VCG input must be a 0 to −5 volt ramp signal with the FREQUENCY dial turned to 10 and the FREQ Hz selector set at X 100, or 1 kHz (the high frequency). At a −4.995 volt input, the generator will be at the minimum frequency for the X 100 range (0.01 X 100 = 1 Hz).

2.5.3 Operation as a Triggered Generator

2.5.3.1 MAIN GENERATOR TRIGGERED INTERNALLY

The main generator may be triggered internally or externally. The procedure for this mode of operation is:

1. Depress AUX MODE – CONT push button.

2. Depress desired AUX FUNCTION.

3. Set auxiliary generator to the desired triggering frequency. This frequency must be less than the main generator frequency.

4. Set main generator to the desired frequency.

5. Select desired output waveform by depressing the corresponding FUNCTION push button on the main generator.

6. Set TRIG LEVEL switch to INT position.

7. Depress MODE – TRIG push button.

8. Adjust TRIG LEVEL control so that the triggered output is present.

2.5.3.2 MAIN GENERATOR TRIGGERED EXTERNALLY

When triggering the main generator externally, an external source of ±1 volt minimum must be connected to the main generator TRIG IN connector. The procedure for this mode of operation is:

1. Connect an external trigger source (at least ±1 V) to the main generator TRIG IN connector.

2. Set external signal source to the desired triggering frequency. This frequency must be less than the main generator frequency.

CAUTION

Input level should not exceed ±50 volts peak.

3. Set main generator to desired frequency.

4. Select desired output waveform by depressing corresponding FUNCTION push button.

5. Set TRIG LEVEL switch to desired negative (–) or positive (+) position, as necessary.

6. Depress MODE – TRIG push button.

7. Adjust TRIG LEVEL control until triggering occurs.

2.5.3.3 AUXILIARY GENERATOR TRIGGERED OPERATION

When triggering the auxiliary generator, an external trigger source or the main generator may be used. The minimum voltage requirement from either trigger source is 4 volts peak. Minimum pulse width must be at least 1 microsecond, and the slew rate may not exceed 8 volts per microsecond. Inversion of the triggered output of the auxiliary generator is push button controlled from the front panel. Depressing the TRIG push button on the auxiliary generator (INVERT position) will cause the triggered cycle to be generated with a 180° phase reversal. The procedure for triggered operation is:

1. Connect main generator or external trigger signal source (square wave or pulse) to auxiliary generator TRIG IN connector.

2. Set main generator or external signal source to desired triggering frequency with at least 4 V peak amplitude.

CAUTION

Input level should not exceed ±30 volts peak.

3. Set auxiliary generator to desired frequency.

4. Select desired output waveform by depressing corresponding AUX FUNCTION push button.

5. Depress AUX MODE – TRIG push button.

2.5.4 Operation as a Gated or Tone Burst Generator

2.5.4.1 MAIN GENERATOR GATED INTERNALLY

The main generator may be gated internally or externally. Gating internally on a square wave will not allow changing the number of cycles, due to the rapid rise time of the waveform. Using a sloping waveform in conjunction with the TRIG LEVEL control will allow selection of any number of discrete cycles to be generated. The procedure for this operation is as follows:

1. Depress AUX MODE – CONT push button.

2. Select desired triggering waveform (sine, triangle or ramp) by depressing the corresponding AUX FUNCTION push button.

3. Set auxiliary generator to desired frequency. This frequency must be lower than the frequency of the main generator.

4. Set main generator to desired frequency.

5. Select desired output waveform by depressing the corresponding FUNCTION push button.

6. Set TRIG LEVEL switch to INT position.

7. Depress MODE – GATE push button.

8. Adjust TRIG LEVEL control until the desired number of cycles in the burst is obtained.

2.5.4.2 MAIN GENERATOR GATED EXTERNALLY

When gating the main generator externally, an external signal source of ±1 volt minimum must be connected to the main generator. This signal cannot be one with a rapid rise time. Since the TRIG LEVEL control must be used to select voltage levels, a triangle, sine or ramp waveform should be used. The procedure for this mode of operation is:

1. Connect external signal source (sine, triangle or ramp) to main generator TRIG IN connector.

CAUTION

Input level should not exceed ±50 volts peak.

2. Set external signal source to desired frequency. This frequency must be lower than the frequency of the main generator.

3. Set main generator to desired frequency.

4. Select desired output waveform by depressing corresponding FUNCTION push button.

5. Set TRIG LEVEL switch to desired negative (–) or positive (+) position.

6. Depress MODE – GATE push button.

7. Adjust TRIG LEVEL control until the desired number of cycles in the burst is achieved.

2.5.4.3 AUXILIARY GENERATOR GATED OPERATION

When gating the auxiliary generator, an external gating source or the main generator may be used. The minimum requirement for either gating source is +2 volts peak. A sine,

triangle or ramp waveform should be used. Inversion of the gated output of the auxiliary generator is push button controlled from the front panel. Depressing the TRIG push button on the auxiliary generator (INVERT position) will cause the gated burst to be generated with a 180° phase reversal. The procedure for this operation is:

1. Connect main generator or external gating source to auxiliary generator TRIG IN connector.

2. Set main generator or external signal source (sine, triangle or ramp) to desired frequency and amplitude (at least +2 volts peak).

CAUTION

Input level should not exceed 30 volts peak.

3. Set auxiliary generator to desired frequency.

4. Select desired output waveform by depressing corresponding AUX FUNCTION push button.

5. Depress AUX MODE – GATE push button.

6. Adjust main generator AMPLITUDE dial or external signal source level until the desired number of cycles in the burst is achieved.

2.5.5 Operation as a DC Voltage Source

The Model 146 Generator may be used as a variable dc voltage source not to exceed 100 mA of current. The AMPLITUDE dial is a calibrated control only when the instrument is connected to a 50 ohm load. The procedure is:

1. Depress the FUNCTION – ⊓ and MODE – TRIG push buttons.

2. Connect the 50Ω OUT connector to the device requiring the dc voltage source.

3. Turn the Trigger Level Control fully ccw.

4. Rotate FREQUENCY dial so that "10" is under the index (oscillation may occur at the bottom of the dial). Maximum level of ±15 V can be obtained into a 50Ω load.

5. The dc level may be adjusted using the AMPLITUDE dial and/or the DC OFFSET controls.

2.5.6 Operation as an Amplitude Modulated Generator

The Model 146 may be internally or externally amplitude modulated. If the auxiliary generator has the desired waveform describing the envelope and the desired frequency range, then the main generator should be amplitude modulated internally using the auxiliary generator.

If the auxiliary generator is not sufficient as the modulating source, an external signal may be applied to the VCA input connector.

In order to better understand the AM operation of the Model 146, please note the following:

"VCA" means Voltage Controlled Amplitude. Voltage controlled amplitude implies amplitude modulation. The VCA signal originates either internally from the auxiliary generator or externally via the VCA IN connector. This VCA signal is summed with the dc level selected by the p-p AMPLITUDE dial. By rotating the AMPLITUDE dial, a different dc offset is applied to the VCA signal. Now the VCA signal with its offset is multiplied times the carrier signal which originates from the main generator. The product of these two signals gives the AM output. Figure 2-6 shows the block diagram describing the algebraic process.

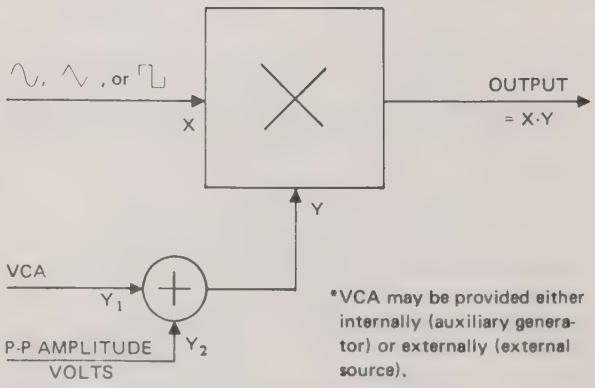


Figure 2-6. X-Y Multiplier Block Diagram

The VCA signal is Y_1, and the dc level from the p-p AMPLITUDE dial is Y_2. Hence, $Y = Y_1 + Y_2$ describes the envelope of the AM output. X is the carrier waveform; therefore, $X \cdot Y$ = AM output.

Figure 2-7 shows several amplitude modulated outputs corresponding to various VCA signals. Note that the percent of modulation may be determined by two factors: the amount of carrier amplitude provided by the AMPLITUDE dial as indicated by the fixed pointer and/or the amplitude of the

6. Depress MODE – TRIG push button.

7. Adjust TRIG LEVEL control until triggering occurs.

2.5.3.3 AUXILIARY GENERATOR TRIGGERED OPERATION

When triggering the auxiliary generator, an external trigger source or the main generator may be used. The minimum voltage requirement from either trigger source is 4 volts peak. Minimum pulse width must be at least 1 microsecond, and the slew rate may not exceed 8 volts per microsecond. Inversion of the triggered output of the auxiliary generator is push button controlled from the front panel. Depressing the TRIG push button on the auxiliary generator (INVERT position) will cause the triggered cycle to be generated with a 180° phase reversal. The procedure for triggered operation is:

1. Connect main generator or external trigger signal source (square wave or pulse) to auxiliary generator TRIG IN connector.

2. Set main generator or external signal source to desired triggering frequency with at least 4 V peak amplitude.

CAUTION

Input level should not exceed ±30 volts peak.

3. Set auxiliary generator to desired frequency.

4. Select desired output waveform by depressing corresponding AUX FUNCTION push button.

5. Depress AUX MODE – TRIG push button.

2.5.4 Operation as a Gated or Tone Burst Generator

2.5.4.1 MAIN GENERATOR GATED INTERNALLY

The main generator may be gated internally or externally. Gating internally on a square wave will not allow changing the number of cycles, due to the rapid rise time of the waveform. Using a sloping waveform in conjunction with the TRIG LEVEL control will allow selection of any number of discrete cycles to be generated. The procedure for this operation is as follows:

1. Depress AUX MODE – CONT push button.

2. Select desired triggering waveform (sine, triangle or ramp) by depressing the corresponding AUX FUNCTION push button.

3. Set auxiliary generator to desired frequency. This frequency must be lower than the frequency of the main generator.

4. Set main generator to desired frequency.

5. Select desired output waveform by depressing the corresponding FUNCTION push button.

6. Set TRIG LEVEL switch to INT position.

7. Depress MODE – GATE push button.

8. Adjust TRIG LEVEL control until the desired number of cycles in the burst is obtained.

2.5.4.2 MAIN GENERATOR GATED EXTERNALLY

When gating the main generator externally, an external signal source of ±1 volt minimum must be connected to the main generator. This signal cannot be one with a rapid rise time. Since the TRIG LEVEL control must be used to select voltage levels, a triangle, sine or ramp waveform should be used. The procedure for this mode of operation is:

1. Connect external signal source (sine, triangle or ramp) to main generator TRIG IN connector.

CAUTION

Input level should not exceed ±50 volts peak.

2. Set external signal source to desired frequency. This frequency must be lower than the frequency of the main generator.

3. Set main generator to desired frequency.

4. Select desired output waveform by depressing corresponding FUNCTION push button.

5. Set TRIG LEVEL switch to desired negative (–) or positive (+) position.

6. Depress MODE – GATE push button.

7. Adjust TRIG LEVEL control until the desired number of cycles in the burst is achieved.

2.5.4.3 AUXILIARY GENERATOR GATED OPERATION

When gating the auxiliary generator, an external gating source or the main generator may be used. The minimum requirement for either gating source is +2 volts peak. A sine,

triangle or ramp waveform should be used. Inversion of the gated output of the auxiliary generator is push button controlled from the front panel. Depressing the TRIG push button on the auxiliary generator (INVERT position) will cause the gated burst to be generated with a 180° phase reversal. The procedure for this operation is:

1. Connect main generator or external gating source to auxiliary generator TRIG IN connector.

2. Set main generator or external signal source (sine, triangle or ramp) to desired frequency and amplitude (at least +2 volts peak).

CAUTION

Input level should not exceed 30 volts peak.

3. Set auxiliary generator to desired frequency.

4. Select desired output waveform by depressing corresponding AUX FUNCTION push button.

5. Depress AUX MODE – GATE push button.

6. Adjust main generator AMPLITUDE dial or external signal source level until the desired number of cycles in the burst is achieved.

2.5.5 Operation as a DC Voltage Source

The Model 146 Generator may be used as a variable dc voltage source not to exceed 100 mA of current. The AMPLITUDE dial is a calibrated control only when the instrument is connected to a 50 ohm load. The procedure is:

1. Depress the FUNCTION – ⊓ and MODE – TRIG push buttons.

2. Connect the 50Ω OUT connector to the device requiring the dc voltage source.

3. Turn the Trigger Level Control fully ccw.

4. Rotate FREQUENCY dial so that "10" is under the index (oscillation may occur at the bottom of the dial). Maximum level of ±15 V can be obtained into a 50Ω load.

5. The dc level may be adjusted using the AMPLITUDE dial and/or the DC OFFSET controls.

2.5.6 Operation as an Amplitude Modulated Generator

The Model 146 may be internally or externally amplitude modulated. If the auxiliary generator has the desired waveform describing the envelope and the desired frequency range, then the main generator should be amplitude modulated internally using the auxiliary generator.

If the auxiliary generator is not sufficient as the modulating source, an external signal may be applied to the VCA input connector.

In order to better understand the AM operation of the Model 146, please note the following:

"VCA" means Voltage Controlled Amplitude. Voltage controlled amplitude implies amplitude modulation. The VCA signal originates either internally from the auxiliary generator or externally via the VCA IN connector. This VCA signal is summed with the dc level selected by the p-p AMPLITUDE dial. By rotating the AMPLITUDE dial, a different dc offset is applied to the VCA signal. Now the VCA signal with its offset is multiplied times the carrier signal which originates from the main generator. The product of these two signals gives the AM output. Figure 2-6 shows the block diagram describing the algebraic process.

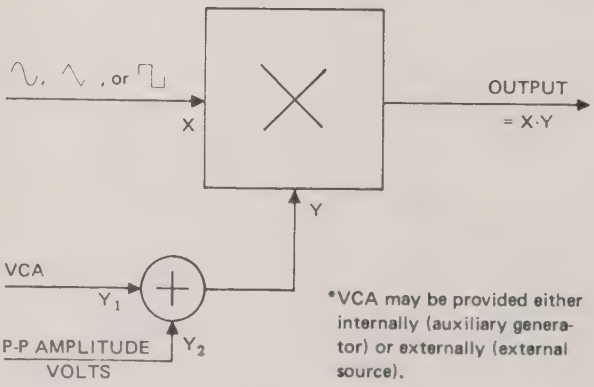


Figure 2-6. X-Y Multiplier Block Diagram

The VCA signal is Y_1, and the dc level from the p-p AMPLITUDE dial is Y_2. Hence, $Y = Y_1 + Y_2$ describes the envelope of the AM output. X is the carrier waveform; therefore, $X \cdot Y$ = AM output.

Figure 2-7 shows several amplitude modulated outputs corresponding to various VCA signals. Note that the percent of modulation may be determined by two factors: the amount of carrier amplitude provided by the AMPLITUDE dial as indicated by the fixed pointer and/or the amplitude of the

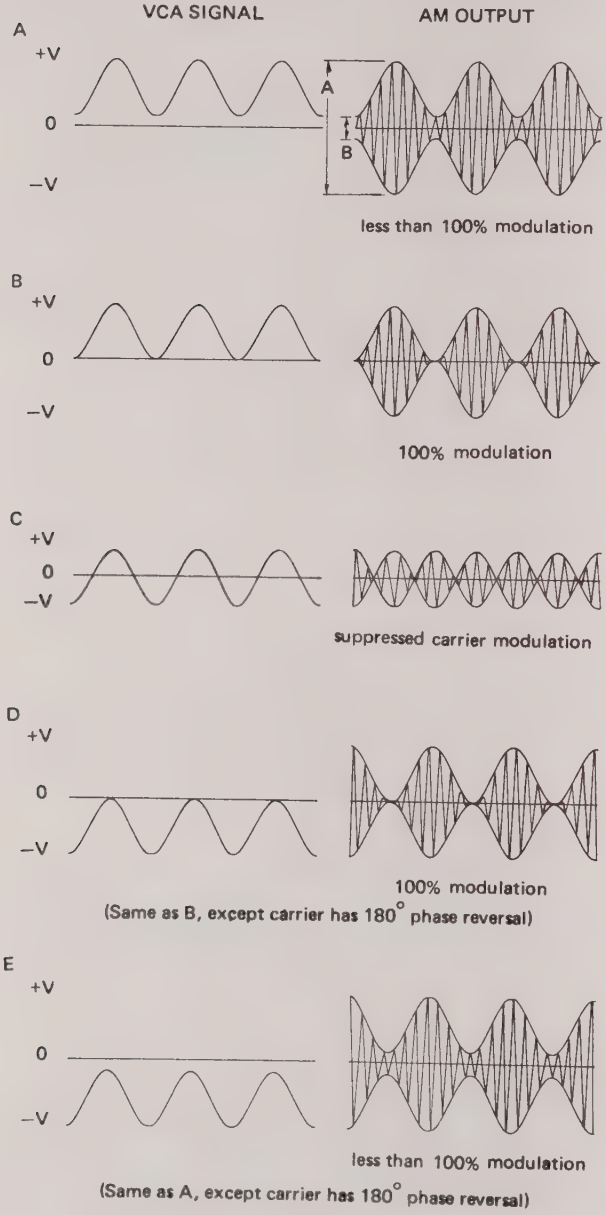


Figure 2-7. Amplitude Modulating Input and the Resultant Output

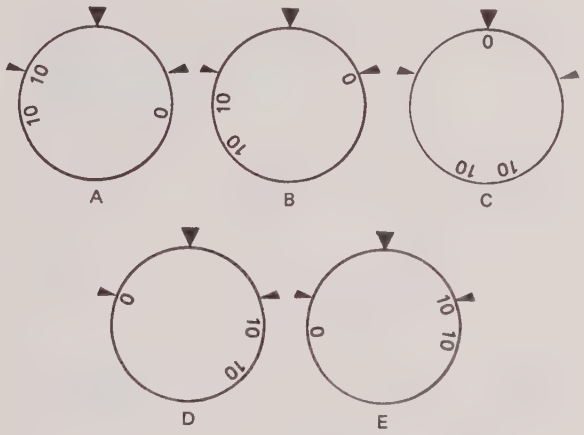
modulating waveform. When modulating internally, the percent of modulation is established using both the p-p AMPLITUDE dial and the AM LIMITS control. The p-p AMPLITUDE dial is providing carrier amplitude and the AM LIMITS control is varying the amplitude of the modulating waveform from the auxiliary generator. These pointers are calibrated, and the percent of modulation may be determined as follows (see Figure 2-7, Diagram A):

$$\frac{A-B}{A+B} \times 100 = \%\ \text{of AM}$$

where A = the position of the left hand pointer

and B = the position of the right hand pointer

For example, the following AMPLITUDE dial and pointer positions provide the modulation shown in Figure 2-7.



When modulating with an external waveform, the AM LIMITS control does not control the gain of this signal and, therefore, the pointers may not be used to calibrate the amount of modulation. The gain must be adjusted externally. The p-p AMPLITUDE dial is the only control to set the amount of modulation.

Figure 2-8 provides a nomograph for several different externally applied modulating waveforms. It allows you to determine the peak limits of the amplitude modulated output. The following examples are provided for clarification:

Example 1 displays suppressed carrier modulation. The input must be symmetrical about ground of the Model 146. See Figure 2-7, Diagram C, for a display of the VCA input waveform and the resultant modulated output.

Example 2 shows 100% modulation. The envelope is 4 volts peak to peak. The input sine wave is 2 volts p-p with the negative peak equal to zero as referenced to signal ground of the Model 146. See Figure 2-7, Diagram B, for waveform display.

Example 3 illustrates the effect of using the AMPLITUDE dial together with a VCA input. The result is less than 100%

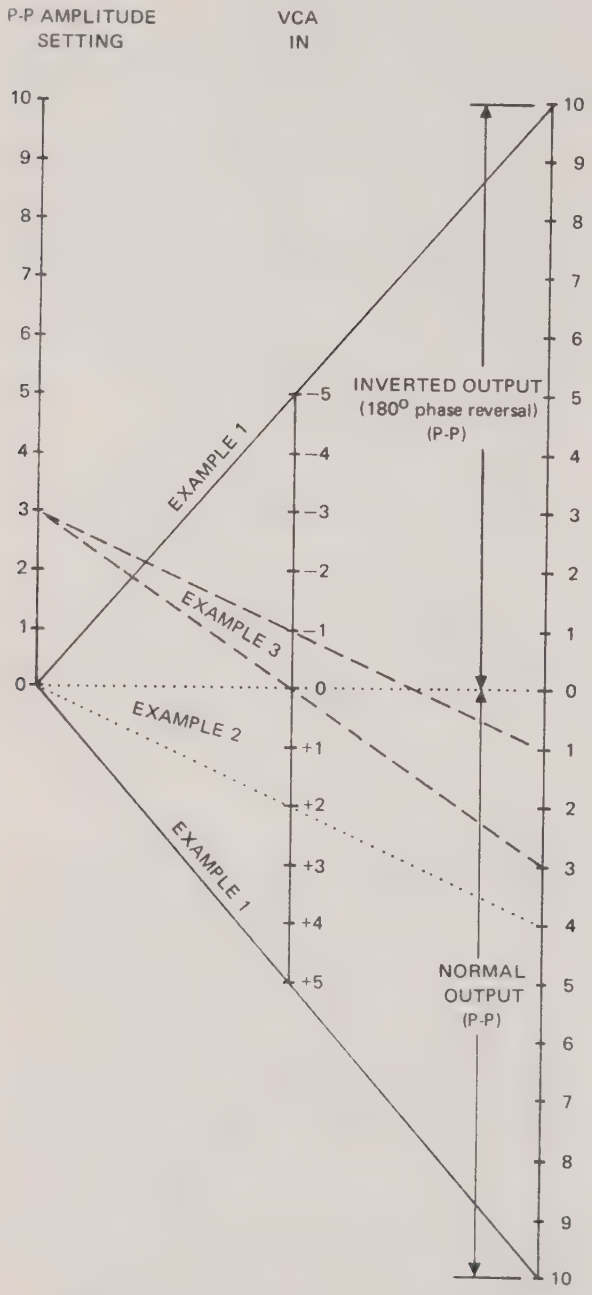


Figure 2-8. Amplitude Modulation Nomograph for an External Input

modulation, since the AMPLITUDE dial has offset the VCA input above signal ground. The effect is shown in Figure 2-7, Diagram A.

The following step-by-step procedures may be used to set up the generator for internal or external AM.

NOTE

The AM LIMITS control which spreads the caliper pointers around the AMPLITUDE dial is only used when modulating internally. Depressing the AM push button enables this control. An external input to the VCA is not affected by this control.

INTERNAL AM

1. Depress the desired FUNCTION push button to select the carrier waveform.
2. Depress the MODE – CONT push button. You may also operate in the TRIG or GATE mode for other applications.
3. Depress the AUX MODE – CONT push button.
4. Depress the desired AUX FUNCTION push button to select the modulating waveform.
5. Set the carrier frequency using the main generator.
6. Set the modulating frequency of the envelope using the auxiliary generator.
7. Depress AM push button.
8. Vary the AM LIMITS control and the p-p AMPLITUDE dial to set the desired amount of modulation.

EXTERNAL AM

1. Depress the desired FUNCTION push button on the main generator to select the carrier waveform.
2. Depress the MODE – CONT push button. You may also operate in the TRIG or GATE mode for other applications.
3. Set the carrier frequency using the main generator.
4. Be sure the AM push button is in the out position.
5. Connect the modulating waveform to the VCA input connector.
6. The percent of modulation may be varied using the AMPLITUDE dial on the main generator.

2.5.7 Operation as the Horizontal Driver of an Oscilloscope or X-Y Recorder

The Model 146 may be used to drive a display device to show many network response characteristics, such as frequency versus amplitude and frequency versus impedance. This is possible because the GCV OUT (No. 37, Paragraph 2.3) on the rear panel makes available an output voltage which is directly proportional to the instantaneous output frequency of the generator. As the main FREQUENCY dial is rotated, the GCV voltage changes proportionally with the change in frequency. This feature is used to calibrate the graticule of an oscilloscope or the X-axis of an X-Y recorder *directly in the frequency domain.* No time to frequency domain conversion is necessary.

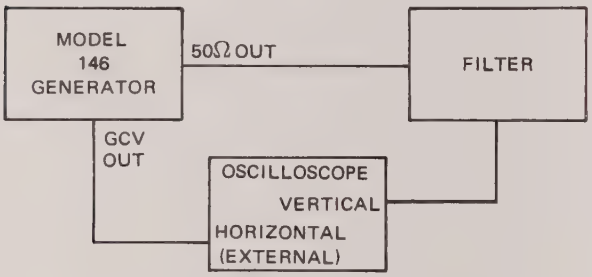


Figure 2-9. Test Setup for an Oscilloscope

Figure 2-9 shows a typical test setup in which GCV is used. The following step-by-step procedure demonstrates how to use GCV with an oscilloscope. In this example, assume that a filter is to be swept and a frequency versus amplitude plot is required.

1. Select the frequency range in which the sweep is to occur.
2. Rotate the FM LIMITS control and spread the calipers to the desired start and stop frequencies. (FM push button should be in the out position.)
3. Select the waveform to be used by depressing the desired FUNCTION push button on the main generator.
4. Depress MODE – CONT push button.
5. DC OFFSET should be OFF.
6. AM push button should be in out position.
7. Set AMPLITUDE dial and multiplier for the desired output.
8. Depress the AUX MODE – CONT and AUX FUNCTION – ∿ .
9. Set AUX FREQUENCY to desired sweep rate.
10. Connect the instruments as shown in Figure 2-9. Be sure scope is in the external horizontal mode.
11. Rotate the main FREQUENCY dial so that frequency which was adjacent to the left hand pointer (low frequency sweep limit) is now under the center index.

    Adjust the horizontal position of the scope so that the vertical component line is aligned with the left hand major vertical division.
12. Rotate the main FREQUENCY dial so that the frequency which was adjacent to the right hand pointer (high frequency sweep limit; see step 2) is now under the center index.

    Adjust the scope horizontal gain so that the vertical component is on the right hand major vertical division.
13. Repeat steps 11 and 12 to eliminate scope gain and position interaction.
14. Return main FREQUENCY dial to the position established in step 2.
15. Depress the FM push button. The scope will now show a frequency response of the filter. The sweep rate should be fast for a good envelope display.

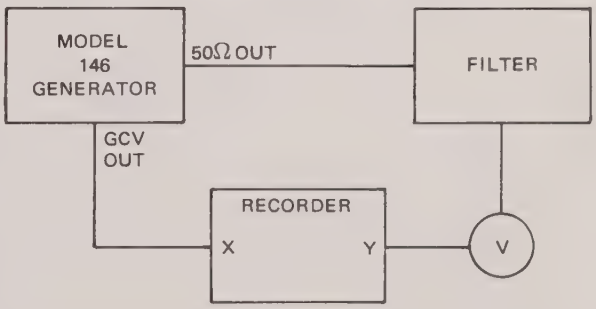


Figure 2-10. Test Setup for an X-Y Recorder

An X-Y recorder may also be driven with the GCV. See Figure 2-10. The procedure is similar to that for an oscilloscope, except that the auxiliary generator signal must be a triggered triangle (–∿–) waveform. The X-axis of the plotter may be calibrated in frequency by adjusting the horizontal gain in the same way as with the scope.

2.5.8 Operation as a Pulse Generator

The following pulse outputs are provided by the Model 146:

SINGLE PULSE DOUBLE PULSE PULSE TRAIN

The pulses may be either positive or negative by rotating the AMPLITUDE dial to either polarity. They may be unipolar or bipolar. The pulses may be rectangular, sinusoidal, triangular or sawtooth in shape.

The duty cycle may be continuously varied over a range of 1:19 to 19:1 by using a symmetry control. Pulse widths as narrow as 50 nanoseconds may be achieved.

Pulses may be generated in two ways:

1. By triggering a single cycle or gating two or more cycles of square waveform from the main generator, the repetition rate is controlled by the trigger source frequency and the pulse width is set by the main generator frequency. Refer to Paragraph 2.5.3 for trigger operation or Paragraph 2.5.4 for gated operation.

2. By using the symmetry control on the rear panel, the pulse width may be varied. The main generator FREQUENCY control selects the repetition rate. The symmetry control in effect is varying the duty cycle of the selected waveform over a range of 1:19 to 19:1. This control divides the frequency by approximately 10 when out of the detent position.

SECTION 3
CIRCUIT DESCRIPTION

3.1 GENERAL DESCRIPTION (Main Generator)

3.1.1 VCG Generator

A simplified block diagram of the VCG generator is shown in Figure 3-1. Triangle and square signals are generated simultaneously in the generator loop circuit. The triangle is then applied to a sine converter and amplified.

The frequency is controlled by the current from the VCG amplifier which, in turn, is controlled by the voltage from the VCG summing amplifier. Voltage from the VCG sum-

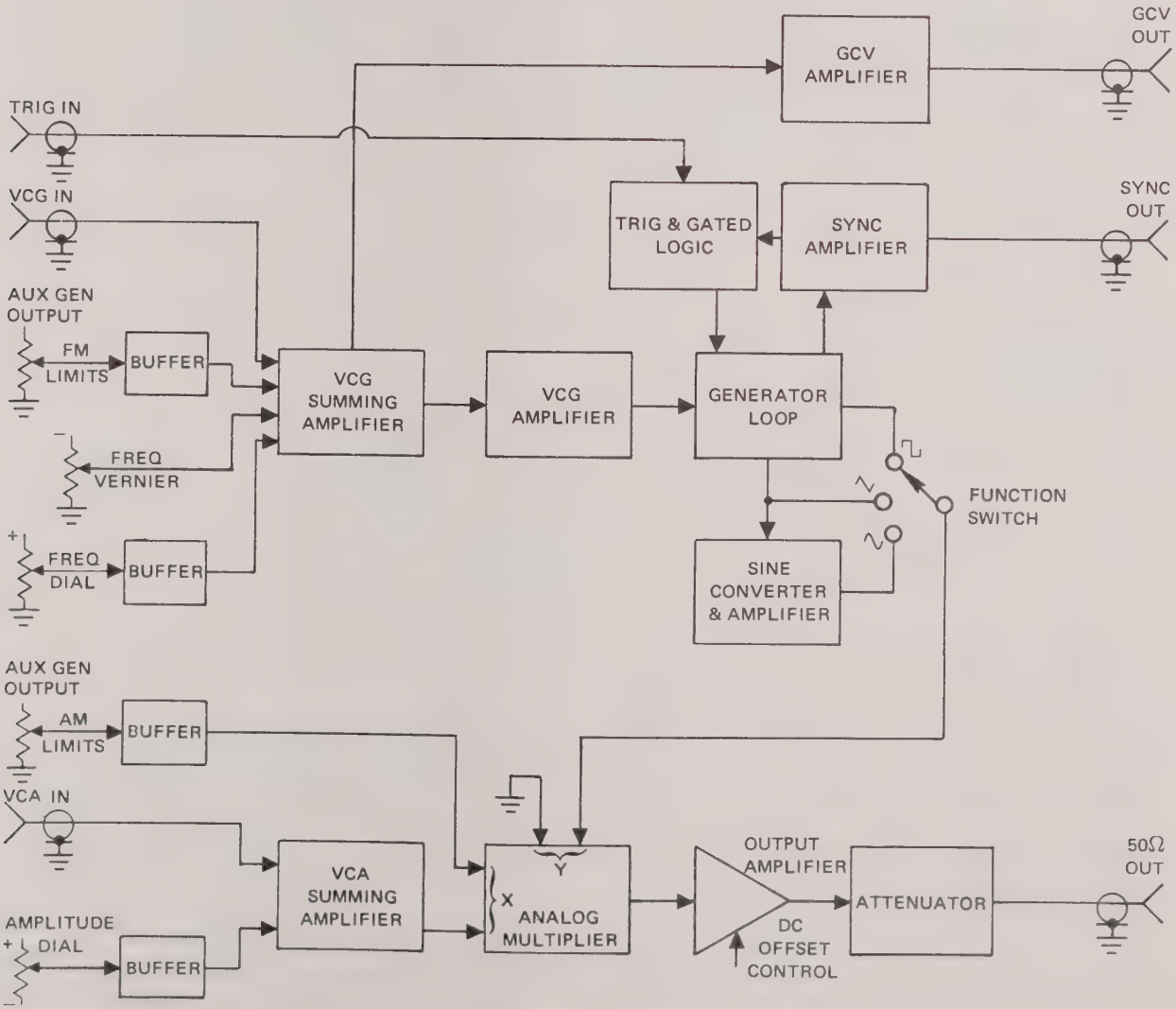


Figure 3-1. VCG Generator Simplified Block Diagram

ming amplifier is also fed into the GCV amplifier which gives a generator control voltage that is proportional to frequency.

One of the signals, square, triangle or sine, is fed into the X-Y multiplier and the amplitude is controlled by the VCA summing amplifier and AM limits buffer. The signal is then fed into the output amplifier. DC offset voltage can be varied positively, or negatively from the front panel dc offset control. The square wave from the triangle generator circuit is also fed into a sync amplifier to generate a sync output.

3.2 THEORY OF OPERATION

3.2.1 Generator Loop

When the voltage at point D is positive, the diodes CRA and CRD are reverse biased and CRB and CRC are forward biased. (See Figure 3-2.) Therefore, the current I+ is charging the capacitor **C** which causes the voltage at points **A** and **B** to rise. As soon as the voltage at point **B** reaches +1.25 V, the output of the hysteresis switch will switch negative and thus reverse the current flow. The current I− is drawn from capacitor **C**. Again, the hysteresis switch will switch positive when the voltage at **B** is below −1.25 V. Thus, triangle and square signals are generated simultaneously.

The output frequency depends on the size of the capacitor selected and the amount of currents, I+ and I−, charging the capacitor. Currents are controlled by the VCG amplifier which, in turn, is controlled by the voltage from the VCG summing amplifier.

3.2.2 VCG Amplifier and Current Sources

The voltage used to control the output frequency from the VCG amplifier is applied to point **A** of the VCG amplifier. (See Figure 3-3.) ICA and ICC are used to shift the control voltage ground reference to the power supply reference. ICB and ICD are the current source generators. The two current outputs are fed to the triangle generator.

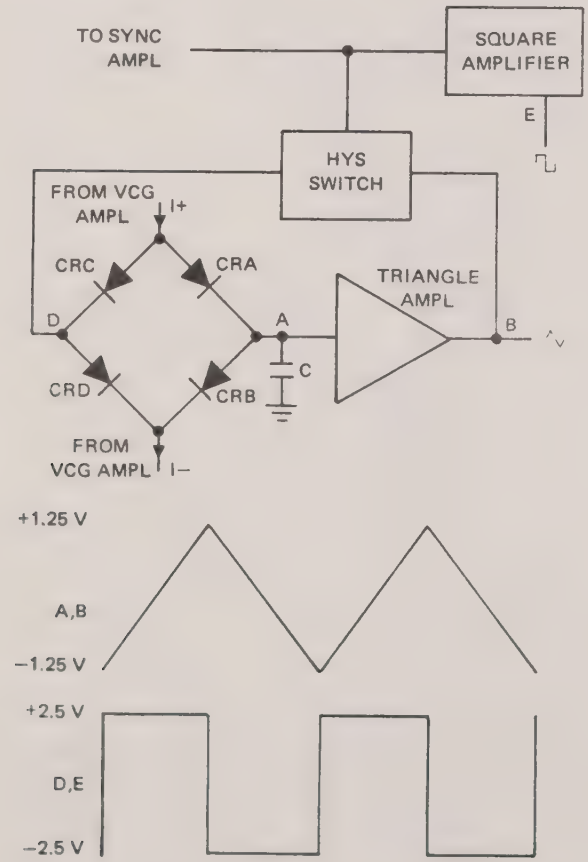


Figure 3-2. Generator Loop Block Diagram

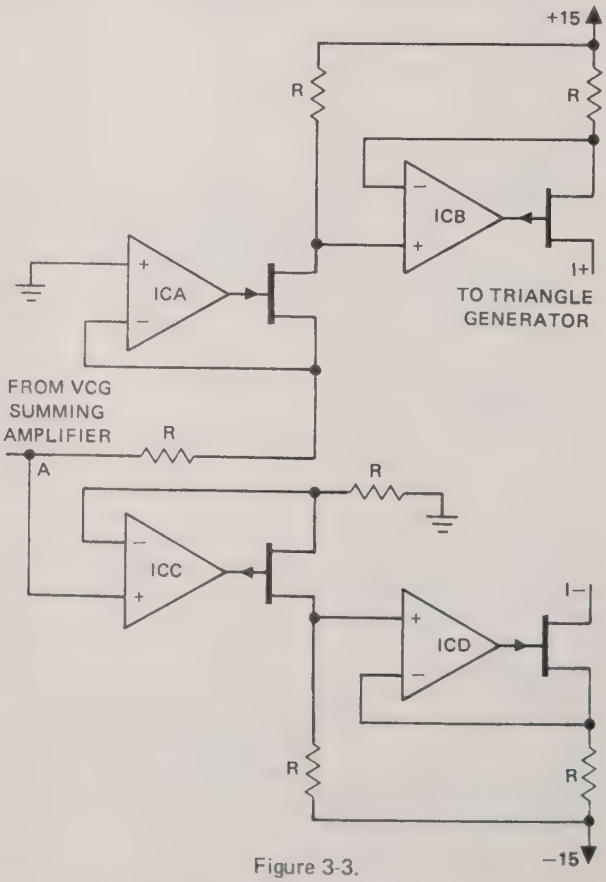


Figure 3-3. Amplifier and Current Source Simplified Circuit

If the current of the negative current source is decreased by 19 times, the fall time of the triangle will be 19 times longer than the rise time of the triangle, resulting in an unsymmetrical waveform and a division of the frequency by a factor of 10. Symmetry of the output waveform can be continuously varied, while frequency is held constant. This can be obtained by gradually increasing the current from the negative current source and decreasing the current from the positive current source in such a way that the period for the triangle to complete one cycle remains constant. To accomplish this, the SYMMETRY ADJUST control on the rear panel must be utilized.

3.2.3 GCV Amplifier

The VCG amplifier output (0 to –5 volts) is fed to the generator control voltage (GCV) amplifier. This is a unity gain, inverting amplifier. From the GCV amplifier, the signal is applied to the GCV OUT connector. The GCV voltage (0 to +5 volts) is proportional to the output frequency.

3.2.4 Sine Converter and Amplifier

The sine wave is produced by feeding the triangle wave into a shaping network composed of resistors and diodes. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus the slope is maximum. As the triangle voltage increases, diodes with current limiting resistors conduct successively, causing the slope of the output to be reduced.

Since the diode break points are mathematically computed and fitted to the true sine shape, the resultant waveform resembles a pure sine wave. Using a complimentary pair of diodes on each break point, the circuitry is completely symmetrical about ground. The sine wave, produced by shaping, is considerably less in amplitude than the triangle wave input and is thus amplified to be equal to the triangle wave.

3.2.5 Capacitance Multiplier

Frequency ranging is achieved by selecting different capacitors. For frequency ranges at X 1 Hz or below, large capacitors are necessary and, therefore, impractical. Instead, a capacitance multiplier circuit is used, and ranging is achieved by changing the multiplication factor which is equivalent to the ranging resistors. The simplified circuit is shown in Figure 3-4.

Because of the nature of the feedback loop connection, A1 and A2, most of the current I+ and I– will be drawn by A2 through R1. Only a small percentage of current is charging and discharging capacitor C1. Therefore, the output frequency will appear much slower. The percentage of current

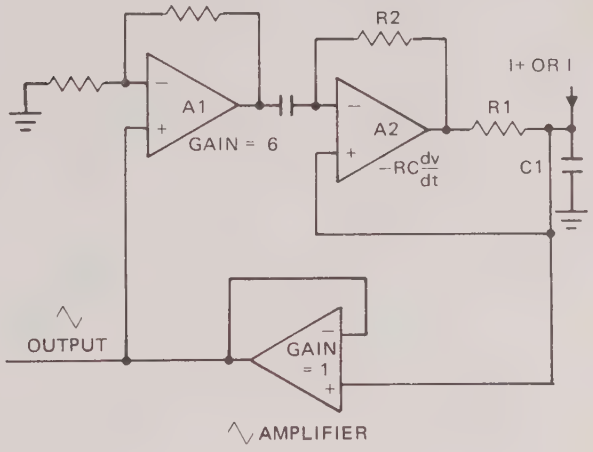


Figure 3-4. Capacitance Multiplier Simplified Circuit

drawn by A2 is precisely controlled by the loop gain and time constant of the capacitance multiplier circuit. Frequency ranging is achieved by changing R2.

3.2.6 X-Y Multiplier, Output Amplifier, and Attenuator

One of the signals is selected and fed into one of the Y inputs and a control voltage from the VCA summing amplifier and AM limits buffer are fed to the X inputs. (Refer to Figure 3-1.) The output from the X-Y multiplier is directly proportional to the product of the X and Y inputs.

The signal is then fed into the output amplifier. This is an inverting amplifier whose output is fed into a step attenuator and then to the output BNC connector (50Ω OUT).

3.2.7 Trigger Gated Modes

The triangle generator will oscillate continuously only if the voltage at **G** is negative which reverse biases CR48. (Refer to Figure 3-5.) This requires that the voltage at **E** or **F** be negative. If both voltages at **E** and **F** are positive, then so is the voltage at **G**. The current through CR48 will keep the voltage of **C** from falling below zero, because CR47 is clamped at zero. This stops the generator from oscillating.

The J-K flip-flop is used to control the timing, so that the triangle will always stop at the end of the cycle. If the trigger signal is reset between times t_1 and t_3, the triangle will stop at time t_3, as shown in the timing diagram.

If the signal at **B** is differentiated before it is applied to the J-K flip-flop, only one cycle of the triangle signal will be generated for each trigger input.

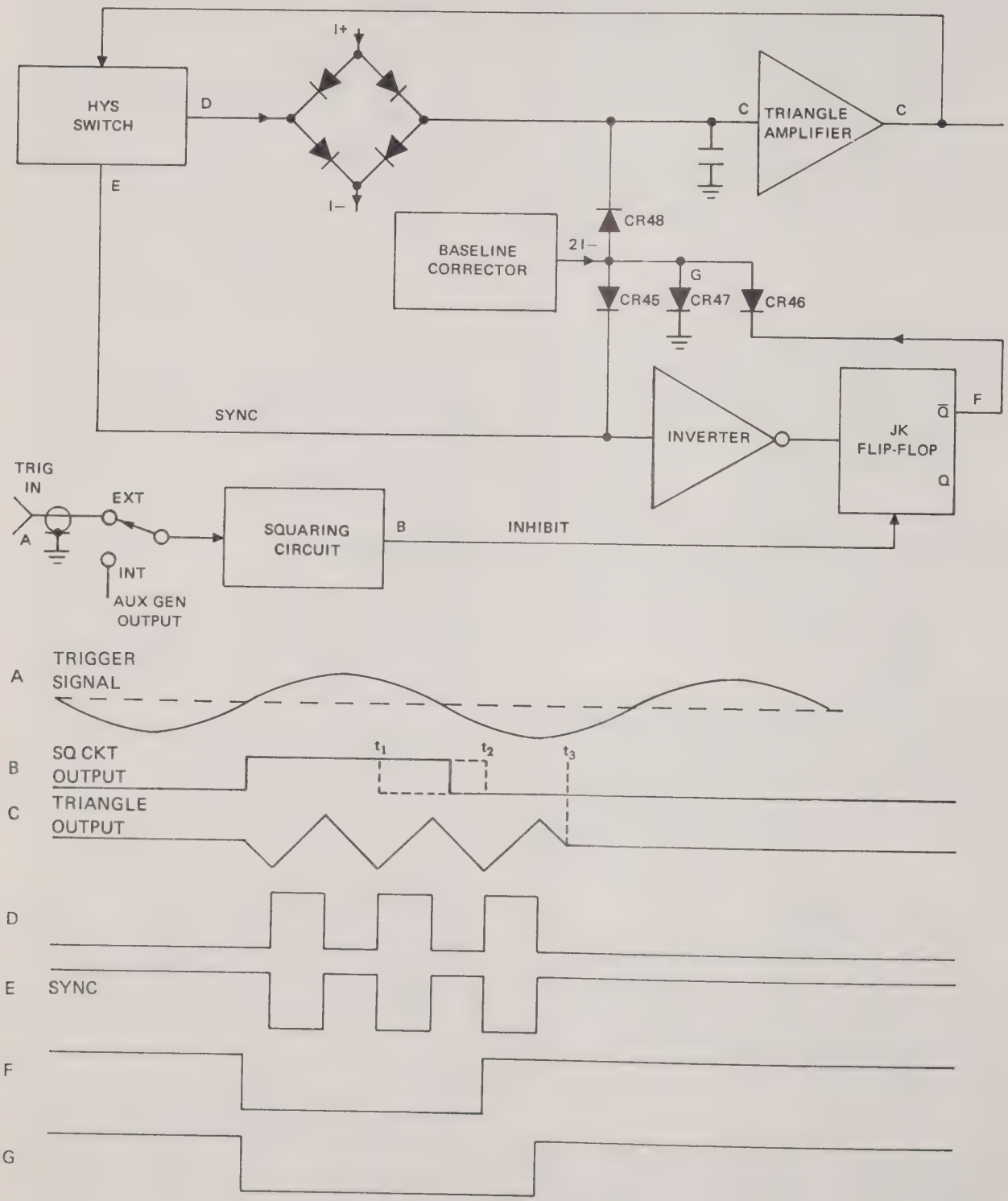


Figure 3-5. Trigger Gated Block and Timing Diagrams

3.3 GENERAL DESCRIPTION (Auxiliary Generator)

A simplified block diagram of the auxiliary generator is shown in Figure 3-6. The dial pot picks off a −dc voltage proportional to frequency from 0 to −15 V. This voltage is fed to a potentiometric buffer to guard against modification of this voltage by load current.

This buffered generator control voltage is fed through a switched resistive voltage divider to the reference or + input of the operational amplifier used as the integrator. This voltage is the exact common mode voltage seen by the integrator. For time symmetrical waveforms (i.e., ∿ ∿ ⎍) this common mode voltage is just half of the output of the dial buffer. For the down ramp ↘ it is nearly all of the dial buffer output and for the up ramp ↗ it is only a small part.

The amplifier and clamp is a circuit which multiplexes alternately between 0 Vdc and the output of the dial buffer on command from the logic generated at the hysteresis switch. The combination of this step function signal and the dc common mode voltage fed to the integrator causes a bipolar voltage to be developed across the integrating resistor which is appropriate for the waveform that is being generated.

A square wave is applied to the input of the integrator. The output of the integrator, a triangle wave, is fed into a hysteresis switch. The hysteresis switch functions like a Schmitt trigger with the limit points set at the waveform extremes, firing when the triangle wave reaches +1.25 volts and −1.25 volts. The firing set the hysteresis switch which reverses the square wave fed into the integrator, causing the triangle wave to reverse direction. The result is simultaneous generation of a square wave and

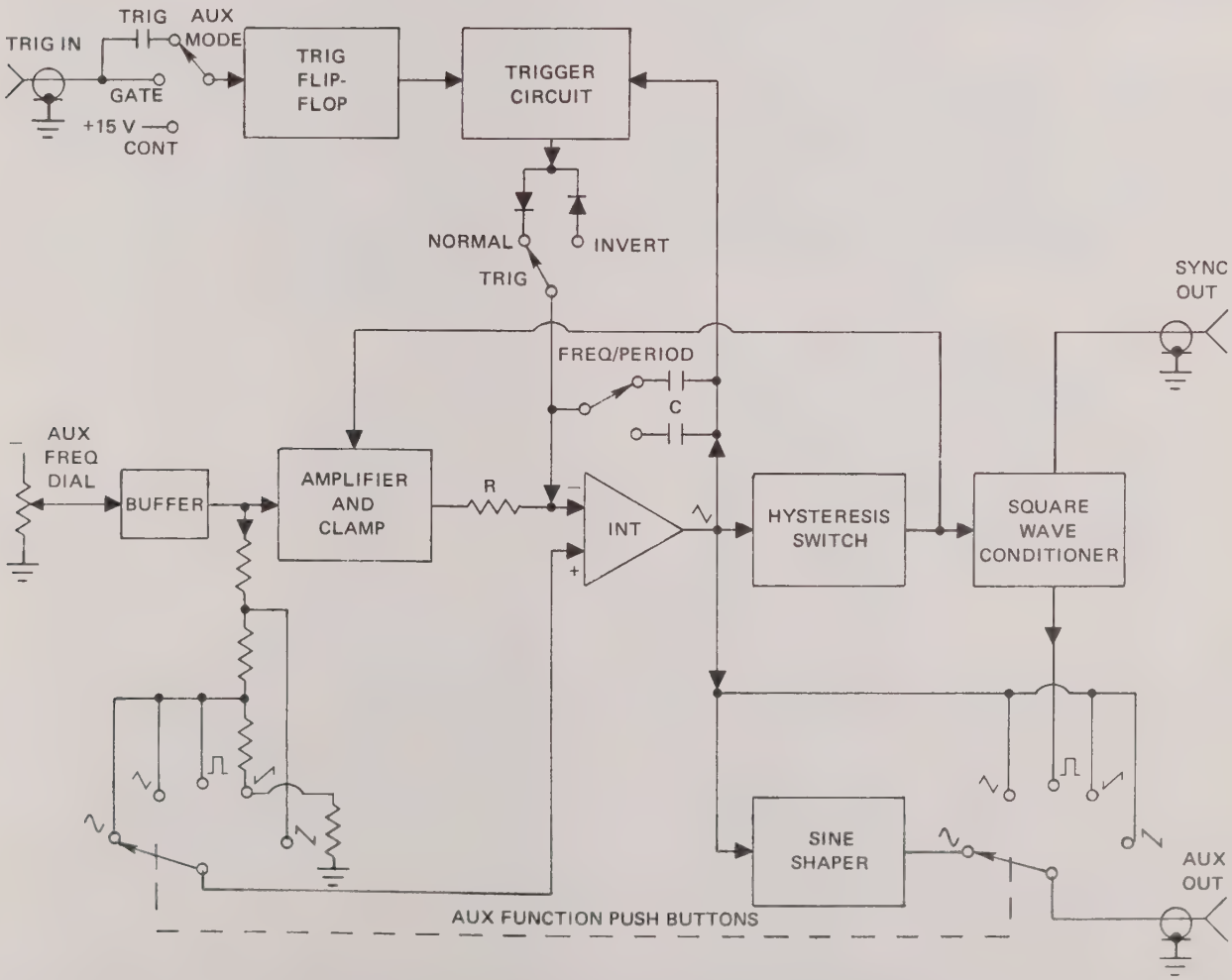


Figure 3-6. Auxiliary Generator Simplified Block Diagram

triangle wave of the same frequency with the positive half cycle of the square wave coincident with the negative slope of the triangle wave.

The frequency of oscillation is determined by the magnitude of capacitor C selected with the FREQ/PERIOD switch and by the amplitude of the square wave fed into the integrating resistor R. Setting the potentiometer for maximum voltage, and thus maximum integrating current, produces an output at maximum frequency. Frequency is directly proportional to the amplitude appearing on the arm of the frequency dial potentiometer.

The sine wave is produced by shaping the triangle wave. The triangle wave is fed into a shaping network composed of resistors and diodes. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus the slope is maximum. As the triangle wave voltage increases, diodes with current limiting resistors conduct, successively, causing the slope of the output to be less.

Since the diode break points are mathematically computed and fitted to the true sine shape, the resultant waveform is an almost pure sine wave. The circuitry is completely symmetrical about ground, using a complimentary pair of diodes on each break point. The sine wave produced by shaping is considerably less in amplitude than the triangle wave input and is thus amplified to be equal to the triangle wave.

Selection of a sync or an inverting sync signal for the trigger flip-flop will determine at which phase, positive or negative, the ground clamping feedback loop will be enabled. (See Figure 3-6.) If the TRIG push button is in the NORMAL (out) position, the integrator output will be integrating positively when clamped to ground at the zero crossing. At this point, the amplitude and clamp will be positive with respect to the integrator input common mode voltage. When a gating pulse is applied to the TRIG IN connector, the integrator will start integrating negatively, since the step source is positive. When the TRIG push button is in the INVERT (depressed) position, the integrator output will be integrating positively when clamped to ground at the zero crossing. At this point, amplifier and clamp will be negative with respect to the integrator input common mode voltage. When a gating pulse is applied to the TRIG IN connector, the integrator will start integrating negatively, since the amplifier and clamp are negative. (See illustration on page 2-3 under number 16.)

The generator trigger circuit is disconnected in the continuous-frequency operation just described. When a trigger or gated operation is selected, this circuit places a shunt path between the integrator input and output. Therefore, there is no output at the BNC until an external trigger/gate signal is applied to the trigger input connector. A trigger input enables the generator for one complete cycle of the selected waveform; then, the generator is disabled until another trigger arrives. A gate input allows the generator to function for the duration of the gate.

SECTION 4
CALIBRATION AND MAINTENANCE

4.1 INTRODUCTION

This section provides instructions for testing, calibrating, trouble-shooting and repairing the Model 146 instrument. The instructions are concise and written for the experienced electronics technician or field engineer. Wavetek maintains a factory-repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. A list of sales/service offices for repair of the instrument is also available on pages iii and iv of this manual. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to facilitate the turnaround time. The main board test point and adjustment locations are shown on the board itself and all points are illustrated in the data package.

4.2 RECOMMENDED TEST EQUIPMENT

Table 4-1 contains a list of recommended test equipment. Any test equipment having equivalent accuracies may be substituted for those listed.

Table 4-1. TEST EQUIPMENT

Type	Required Characteristics
Oscilloscope	To 250 MHz
Oscilloscope	To 30 MHz
Plug-in	Dual Channel
Plug-in	Peak mV measuring capability
Distortion Analyzer	To 600 kHz
Spectrum Analyzer Display	To 50 MHz
IF Section	
RF Section	
Differential Voltmeter	Microvolt dc measurement
Counter-Timer	To 10 MHz 0.1% of reading accuracy

4.3 ACCESS INSTRUCTION

Removal of the top and bottom dust covers affords quick access to all of the components within the unit.

4.3.1 Removing the Dust Cover

1. Unplug the power cord.
2. Unscrew three screws on top cover.
3. Remove top cover.
4. Follow same procedure for bottom cover removal.

4.4 CALIBRATION INSTRUCTIONS

The following paragraphs provide complete sequential calibration procedures for the Model 146 instrument.

NOTE

The entire calibration procedure must be read first to determine initial control settings and test equipment connections required before attempting recalibration. The steps of this procedure should be performed in the sequence given and the parts within each step should also be performed in the same sequence given. See fold-out on page 4-19 for test point location.

4.4.1 Preliminary Procedures

Allow the unit to warm up for at least 30 minutes. Start the calibration by setting the switches and controls as follows:

FREQ Hz Switch	X 100
Frequency VERNIER	CAL
FREQUENCY Dial	10
DC OFFSET Switch	OFF
DC OFFSET Control	fully ccw
TRIG LEVEL Control	fully ccw
TRIG LEVEL Switch	INT
AMPLITUDE Dial	fully ccw
VOLTS P-P Switch	X 1
Amplitude VERNIER	CAL

FREQ/PERIOD Switch	X 10 Hz
AUX FREQUENCY Dial	10
AUX FUNCTION Selector	∿
AUX MODE Selector	CONT
AM Switch	released (off)
MODE Selector	TRIG
FUNCTION Selector	∿
FM Switch	released (off)
SYMMETRY ADJUST	(rear panel) OFF
PWR	depressed (on)

4.4.2 Power Supply Regulation

1. Connect ac power to the instrument and connect the voltmeter leads to TP1 (common) and TP2 (+15 V) on the power supply board.

2. Adjust R21 for a reading of +15 Vdc ±20 mV.

3. Check the voltage at TP3 for −15 Vdc ±50 mV, at TP4 for +28 Vdc ±400 mV, at TP5 for −28 Vdc ±400 mV, and at TP6 for +5 Vdc ±100 mV.

4.4.3 Auxiliary Triangle Amplitude

1. Connect the oscilloscope with a BNC cable to AUX OUT (unloaded). Use a peak mV measuring capability plug-in module in oscilloscope.

2. Adjust the triangle amplitude to ±2.5 V ±50 mV using R42 (+) and R58 (−).

4.4.4 Auxiliary Square Wave Amplitude

1. Depress AUX FUNCTION ⎍ and adjust the square wave amplitude to ±2.5 V ±5 mV using R98 (+) and R110 (−).

4.4.5 Auxiliary Frequency Dial Alignment

1. Set AUX FREQUENCY dial to 10.

2. Set FREQ/PERIOD switch to X 100 and adjust R10 to obtain 1 kHz ±1 Hz.

3. Adjust R10 for optimum frequency on X 100, X 10, X 1, and X 0.1 of FREQ/PERIOD switch.

4. Set FREQ/PERIOD switch to X 1K and adjust C10 for 10 kHz ±10 Hz.

5. Set FREQ/PERIOD switch to X 10K and adjust C12 for 100 kHz ±100 Hz.

6. Set FREQ/PERIOD switch to X 10, AUX FUNCTION selector to ◿ , and adjust R26 to obtain 100 Hz ±0.1 Hz.

7. Set AUX FUNCTION selector to ◺ and adjust R30 to obtain 100 Hz ±0.1 Hz.

8. Set AUX FREQUENCY dial to 1 and adjust R1 to obtain 10 Hz ±0.1 Hz.

9. Set AUX FUNCTION selector to ◿ and adjust R35 to obtain 10 Hz ±0.1 Hz.

10. Repeat steps 6 through 10 until all frequencies are correct.

4.4.6 Auxiliary Sine Distortion, Amplitude, and Balance

1. Set AUX FUNCTION selector to ∿ , FREQ/PERIOD to X 100, and FREQUENCY dial to 10.

2. Adjust R61 to balance output.

3. Adjust R67 to obtain 5 V p-p ±10 mV output.

4. Connect the test equipment as shown in Figure 4-1. Model 146 connects to the AUX OUT.

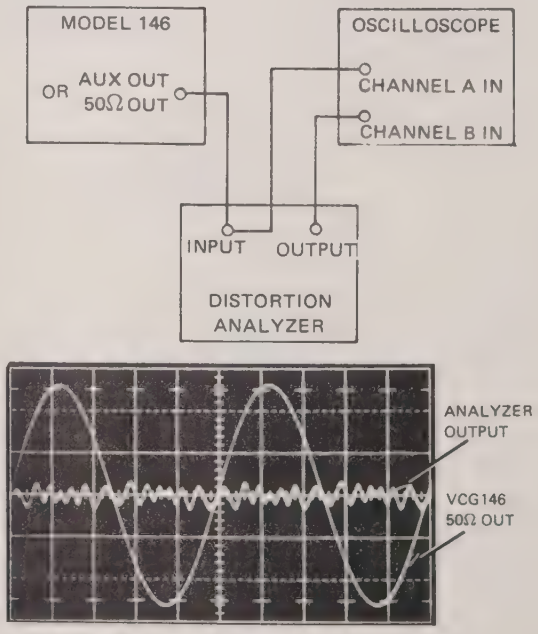


Figure 4-1. Distortion Analysis Test Set Up

5. Adjust R28, R53 and R55 for minimum sine distortion.

6. Repeat steps 2 and 3 to obtain ±2.5 V ±5 mV.

4.4.7 Triangle Amplitude Adjustment

1. Set MODE selector to CONT and AUX MODE selector to TRIG.

2. Connect a X 1 oscilloscope probe to TP7 (∿). Use a peak mV measuring capability plug-in module in oscilloscope.

3. Adjust the triangle amplitude to ±1.25 V ±5 mV, using R96 (+) and R99 (−).

4.4.8 Frequency and Time Symmetry Calibration

1. Set FREQ Hz to X 10K, FREQUENCY dial to 10, and frequency VERNIER to CAL.

2. Adjust R5 to obtain 100 kHz ±100 Hz.

3. Turn FREQUENCY dial to 1/100 of full scale and verify accuracy with oscilloscope. While opening and shorting the VCG IN, adjust R35 for minimum frequency shift.

4. Adjust time symmetry within 0.1% with R18.

5. Set FREQUENCY dial to 1 and adjust R34 to obtain 10 kHz ±10 Hz.

   Check for 1000:1 FM operation. If necessary, readjust R34 to maintain 1000:1 operation and requirements in first paragraph of Step 5.

6. Repeat steps 1 and 4, as necessary, for accurate frequency at 10 and 1 on the dial.

7. Set FREQ Hz to X 1M, FREQUENCY dial to 10, and adjust C31 to obtain an output frequency of 10 MHz ±10 kHz. Check frequency accuracy from 1 to 10 on the dial and readjust C31 to split the error, if necessary.

8. Set FREQ Hz to X 100K, FREQUENCY dial to 10, frequency VERNIER to CAL and adjust C42 to obtain 1 MHz ±1 kHz at the output. Check frequency accuracy from 1 to 10 on the FREQUENCY dial and readjust C42 to split the error, if necessary.

9. Set FREQUENCY dial to 10 and frequency VERNIER to CAL position.

10. Set FREQ Hz to X 1K and adjust R6 to obtain 10 kHz ±10 Hz.

11. Set FREQ Hz to X 100 and adjust R7 to obtain 1000 Hz ±1 Hz.

12. Set FREQ Hz to X 10 and adjust R8 to obtain 100 Hz ±0.1 Hz.

13. Set FREQ Hz to X 1 and adjust R23 to obtain 10 Hz ±0.01 Hz.

14. Adjust R23 for optimum frequency on X 1, X 0.1, X0.01, X0.001 of FREQ Hz selector.

15. Set FREQUENCY dial fully ccw, frequency VERNIER to CAL and FREQ Hz to X 1.

16. Adjust R73 for 0.1% time symmetry.

4.4.9 Sine Distortion

1. Set FREQ Hz to X 100, frequency VERNIER to CAL, FUNCTION selector to ∿ and FREQUENCY dial to 10.

2. Connect X 1 oscilloscope probe to TP8 (∿).

3. Adjust R141 so that the dc offset of the sine amplifier is zero.

4. Connect the test equipment as shown in Figure 4-1. Model 146 connects to the 50Ω OUT.

5. Adjust R134, R135 and R136 for minimum sine wave distortion.

6. Set FREQ Hz to X 1K and readjust R134, R135 and R136 for optimum sine distortion.

7. Alternately perform steps 5 and 6 until the least amount of sine wave distortion is obtained on both ranges (typically 0.14%).

8. Connect oscilloscope probe to TP8 (∿).

9. Adjust R159 for a 2.5 V p-p ±5 mV signal output from the sine amplifier.

10. Readjust R141 so that the dc offset of the sine amplifier is 0 V ±5 mV.

4.4.10 X-Y Multiplier Adjustment

1. Set FREQ Hz to X 100, FREQUENCY dial to 10 and FUNCTION selector to ∿ .

2. Turn AMPLITUDE dial to null waveform at 50Ω OUT (loaded with 50Ω).

3. Adjust R231 for 0 V ±10 mV.

4. Set amplitude to 1 V p-p and decrease amplitude until the straight sides of the triangle wave become parabolic.

NOTE

Avoid decreasing the amplitude so far that the waveform folds over into a null.

5. Adjust R201 for an unwarped triangle.

NOTE

It is not necessary to perform step 5 with great care at the initial higher amplitudes.

6. Repeat steps 4 and 5 until the triangle is down to about 50 mV p-p.

NOTE

It is normal for the 50 mV triangle to be fuzzy and somewhat distorted, but the potentiometer should be set for optimum linearity. Increase oscilloscope sensitivity as necessary to observe the signal.

7. Readjust R231 for 0 V ±10 mV.

8. Set AMPLITUDE dial to 0 and adjust R9 on switch board to null waveform at 50Ω OUT.

9. Turn AMPLITUDE dial to either 10 and adjust triangle from 50Ω OUT (loaded with 50Ω) for ±5 V peak ±25 mV with R228 (amplitude) and R205 (balance).

10. Turn AMPLITUDE dial to other 10 and check to assure waveform is within ±5 V peak ±50 mV. If not, reset R228 and R205 for optimum amplitude and balance at both 10s.

11. Set FUNCTION selector to ∿ and AMPLITUDE dial to either 10.

12. Connect the test equipment as shown in Figure 4-1.

13. Adjust R195 for minimum sine distortion at both 10s of the AMPLITUDE dial.

14. Set FUNCTION selector to ⎍ and repeat steps 10 through 13 for optimum amplitude and balance and minimum sine distortion.

4.4.11 Square Wave Amplitude Adjustment

1. Set FUNCTION selector to ⎍ and set AMPLITUDE dial to either 10.

2. Adjust the square wave amplitude from 50Ω OUT (loaded with 50Ω) for ±5 V ±25 mV using R167 and R169.

3. Turn dial to other 10 and check that waveform is within ±5 V ±50 mV. If not, reset R167 and R169 for optimum amplitude at both 10s.

4.4.12 Sine Wave Amplitude and Balance Adjustment

1. Set FUNCTION selector to ∿ and AMPLITUDE dial to either 10.

2. Adjust the sine wave amplitude from 50Ω OUT (loaded with 50Ω) for ±5 V ±25 mV using R159 (amplitude) and R141 (balance).

3. Turn AMPLITUDE dial to other 10 and check to assure the waveform is within ±5 V ±50 mV. If not, reset R159 and R141 for optimum amplitude at both 10s.

4.4.13 AM LIMITS Adjustment

1. Set FUNCTION selector to ⎍ , MODE selector to TRIG, AM LIMITS control fully cw, AUX MODE selector to CONT, AUX FUNCTION to ⎍ , and depress AM push button.

2. Adjust R5 on switch board for square wave amplitude at 50Ω OUT (loaded with 50Ω) for 10 V p-p ±50 mV.

4.4.14 Trigger Base Line Adjustment

1. Set AUX MODE selector to TRIG and FUNCTION selector to ∿ ; release AM push button and turn AM LIMITS control fully cw.

2. Adjust R80 for 0 V ±5 mV at 50Ω OUT (loaded with 50Ω).

3. Turn AMPLITUDE dial to other 10 and split the error from 0 V by readjusting R80.

4. Set FREQUENCY dial to 1/100 of full scale and adjust R257 to set base line to 0 V ± error accrued in step 3.

not really necessary

5. Check to assure base line remains within ±100 mV at all FREQUENCY dial settings from full scale to 1/100 of full scale.

4.4.15 GCV OUT Adjustment

1. Set MODE selector to CONT and FREQUENCY dial to 10.

2. Adjust R52 to obtain +5 Vdc ±10 mV at GCV OUT connector.

4.4.16 High Frequency Response Adjustment

1. Set FREQ Hz to X 0.1M, FREQUENCY dial to 10 and FUNCTION selector to ⊓⊔ .

2. Adjust C85 for optimum square wave, without peaking, from 5 V p-p to 10 V p-p output amplitude.

3. Set FUNCTION selector to ∿ , FREQUENCY dial to 10 and FREQ Hz to X 1M.

4. Adjust C26 to obtain 10 V p-p output amplitude.

4.5 CORRECTIVE MAINTENANCE

This portion of the manual presents a systematic approach to trouble-shooting. It is composed of two parts. Part one (see 4.5.1) is a quick guide for locating the area of the problem. Part two (see 4.5.2) contains 10 tables which are given as detailed supplements to part one.

The following abbreviations are used:

Symbol	Meaning
B	Base (transistor)
C	Collector (transistor)
E	Emitter (transistor)
G	Gate (FET)
S	Source (FET)
D	Drain (FET)
CR	Diode
Qn	Transistor number (n)
V_{GS}	Voltage between gate and source (FET)
Q	Output terminal (flip-flop)
$\overline{Q}$	Inverting output terminal (flip-flop)

4.5.1 Quick Trouble-Shooting Guide

Symptom	Corrective Action
Blown Line Fuse	Replace fuse. If it blows again, check the following: 1. Solder bridge or wire connection shorted. 2. Q39 and/or Q40 shorted in output amplifier. 3. Bypass capacitors for power supply are shorted. 4. Follow Table 4-2 to locate the short in a particular power supply.
+15 V Power Supply Malfunctions	1. Voltage low: a. Transformer output low. b. Extra current loading. Check for overheated and defective component in the circuit. c. Q4 or Q3 is shorted. d. Q2 is open. e. CR10 is shorted. f. IC1 is defective. 2. Voltage high: a. Power transistor Q1 or Q2 is shorted. b. Q4 is open. c. IC1 is defective. 3. High frequency oscillation (MHz): a. C4 or C5 at IC1 is defective. b. One of the semiconductors in another part of the circuit is oscillating. Locate by using hand to touch the most sensitive area of the circuit boards. 4. Large 60 cycle noise: defective filter capacitor, C1 or C9.
Other Power Supply Malfunctions	1. Follow Table 4-2 to locate the problem to a particular power supply. 2. Use similar procedure for trouble-shooting as in the +15 V power supply malfunctions.

Quick Trouble-Shooting Guide (Continued)

Symptom	Corrective Action
MAIN GENERATOR	
No Output Signals	1. If no ∿ signal is present at output of ∿ amplifier (G of Q6), follow Table 4-3 for trouble-shooting. 2. Check for faulty wiring to and from FUNCTION selector (switch board). 3. If no signal is present at R238 and R241 with the ∿ FUNCTION selected, follow Table 4-10 to check out the X-Y multiplier and Table 4-5 to check out the output amplifier.
No ∿ , ⊓ or SYNC Output	Follow Table 4-10 to check out the corresponding circuit.
⊓ Rise/Fall Time Abnormally Slow	1. Malfunctioning ⊓ amplifier. 2. One of the capacitors in the output amplifier is open. 3. C85 (output amplifier) is not calibrated.
Frequency Accuracy Out of Specification	1. Check frequency calibration. 2. Check for defective C34, C45 to C52, CR14 and/or CR16 on main board, if problem is in X 10K to X 1 MHz ranges. 3. Check capacitance multiplier, if problem appears in X 0.001 to X 1 ranges only, using Table 4-6. 4. Check VCG for frequency linearity problem in all ranges, using Table 4-4.
High Frequency Output Has Abnormal Ringing	Defective capacitor in output amplifier.
High Sine Distortion at Low Frequency	1. ∿ amplitude and time symmetry calibration is off. 2. Defective sine converter. 3. Sine converter or X-Y multiplier calibration is off.
High Sine Distortion at High Frequency	1. ⊓ also looks bad, if problem is in the output amplifier. 2. Defective capacitors C34 and C45 to C52 in ∿ amplifier. 3. Defective C29 to C36 in sine amplifier. 4. Defective sine converter.
Unsymmetrical ∿	Follow Table 4-4 to check out VCG circuit.
Amplitude Accuracy Out of Specification	1. Check calibration. 2. Check X-Y multiplier, using Table 4-10.
TRIG and GATE MODE Inoperative	1. Check trigger and gated control switches. 2. Check for correct signals in the trigger circuit, using Table 4-9.
AUXILIARY GENERATOR	
No Aux Output Signal	1. If no ∿ is present at junction of R33 and R34, use Table 4-7. 2. If ∿ signal is present at junction of R33 and R34, check FUNCTION switch and wiring.
No Aux ∿ Output	1. If no ∿ signal is present at pin 4 of IC5 (±125 mV), check for defective sine converter (A1).

Quick Trouble-Shooting Guide (Continued)

Symptom	Corrective Action
No Aux ∿ Output (Cont)	2. If no ∿ signal is present at pin 12 of IC5 (±2.5 V peak), check for defective IC5 and associated circuitry. 3. If ∿ signal is present at pin 12 of IC5, check FUNCTION switch and wiring.
No Aux ⎍ Output	1. If no ⎍ signal is present at the emitter of Q22, check for defective IC7, Q20 – Q22 and associated circuitry. 2. If ⎍ signal is present at the emitter of Q22, check FUNCTION switch and wiring.
TRIG and GATE MODE Inoperative	1. Check trigger and gated control switches. 2. Use Table 4-7.

4.5.2 Trouble-Shooting Guide Tables

4.5.2.1 POWER SUPPLIES

Use Table 4-2 to localize the problem to a particular power supply and associated loading circuitry. In some cases, it is necessary to turn on the power of the unit no more than one or two seconds at a time to prevent it from blowing fuses and further damage circuit components.

NOTE

Be sure to use the correct ground in the following voltage checks.

Table 4-2. POWER SUPPLIES

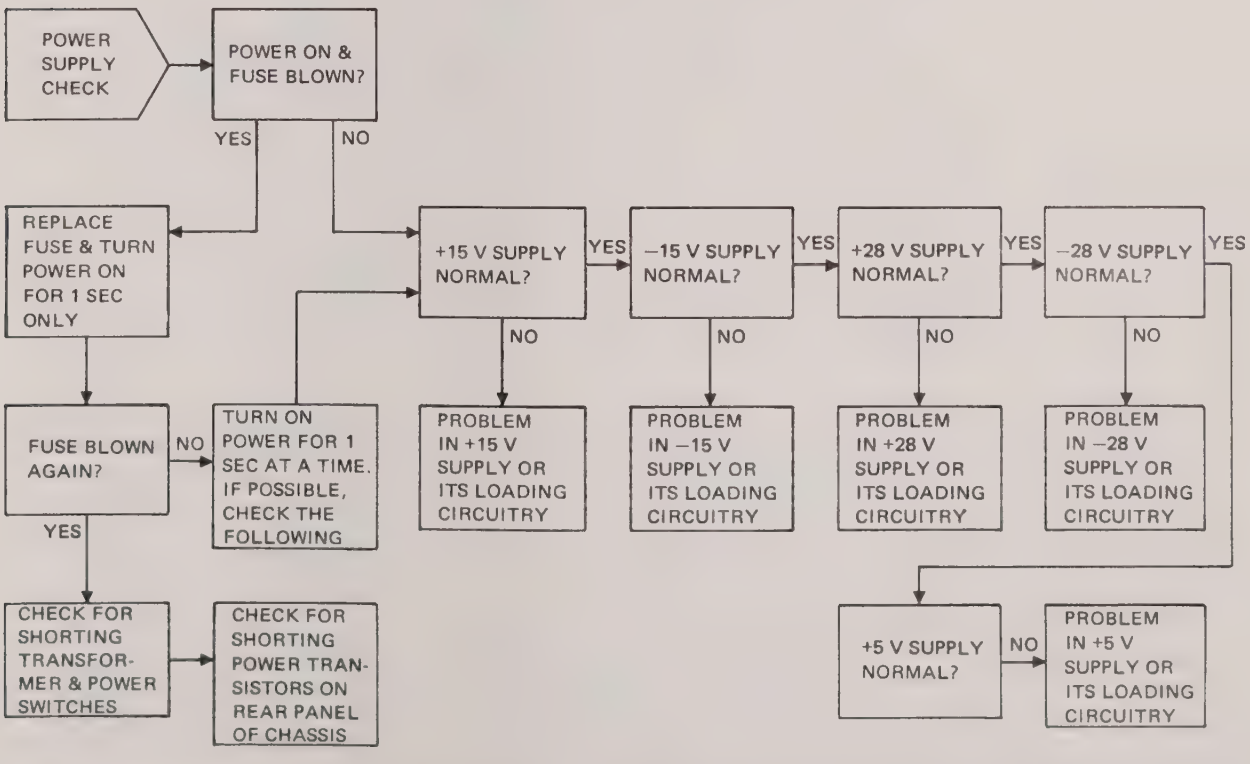

POWER SUPPLY CHECK
POWER ON & FUSE BLOWN?
YES
NO
REPLACE FUSE & TURN POWER ON FOR 1 SEC ONLY
+15 V SUPPLY NORMAL?
YES
−15 V SUPPLY NORMAL?
YES
+28 V SUPPLY NORMAL?
YES
−28 V SUPPLY NORMAL?
YES
NO
NO
NO
NO
FUSE BLOWN AGAIN?
NO
TURN ON POWER FOR 1 SEC AT A TIME. IF POSSIBLE, CHECK THE FOLLOWING
PROBLEM IN +15 V SUPPLY OR ITS LOADING CIRCUITRY
PROBLEM IN −15 V SUPPLY OR ITS LOADING CIRCUITRY
PROBLEM IN +28 V SUPPLY OR ITS LOADING CIRCUITRY
PROBLEM IN −28 V SUPPLY OR ITS LOADING CIRCUITRY
YES
CHECK FOR SHORTING TRANSFORMER & POWER SWITCHES
CHECK FOR SHORTING POWER TRANSISTORS ON REAR PANEL OF CHASSIS
+5 V SUPPLY NORMAL?
NO
PROBLEM IN +5 V SUPPLY OR ITS LOADING CIRCUITRY

Table 4-3. TRIANGLE AMPLIFIER, COMPARATOR, AND HYSTERESIS SWITCH

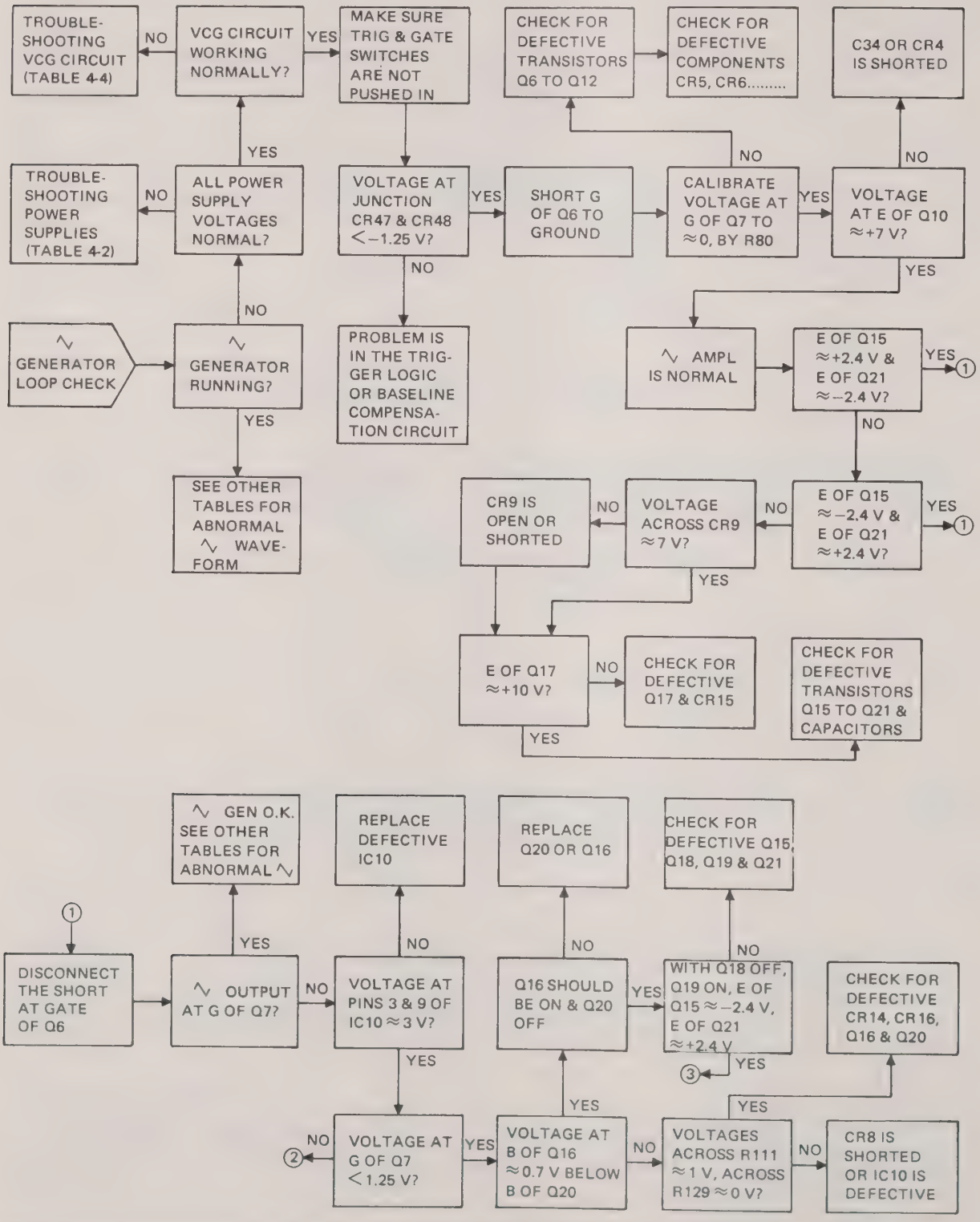

TROUBLE-SHOOTING VCG CIRCUIT (TABLE 4-4)
NO
VCG CIRCUIT WORKING NORMALLY?
YES
MAKE SURE TRIG & GATE SWITCHES ARE NOT PUSHED IN
CHECK FOR DEFECTIVE TRANSISTORS Q6 TO Q12
CHECK FOR DEFECTIVE COMPONENTS CR5, CR6.....
C34 OR CR4 IS SHORTED
YES
NO
NO
TROUBLE-SHOOTING POWER SUPPLIES (TABLE 4-2)
NO
ALL POWER SUPPLY VOLTAGES NORMAL?
VOLTAGE AT JUNCTION CR47 & CR48 < −1.25 V?
YES
SHORT G OF Q6 TO GROUND
CALIBRATE VOLTAGE AT G OF Q7 TO ≈0, BY R80
YES
VOLTAGE AT E OF Q10 ≈+7 V?
YES
NO
NO
∿ GENERATOR LOOP CHECK
∿ GENERATOR RUNNING?
PROBLEM IS IN THE TRIG-GER LOGIC OR BASELINE COMPENSA-TION CIRCUIT
∿ AMPL IS NORMAL
E OF Q15 ≈+2.4 V & E OF Q21 ≈−2.4 V?
YES
1
YES
NO
SEE OTHER TABLES FOR ABNORMAL ∿ WAVE-FORM
CR9 IS OPEN OR SHORTED
NO
VOLTAGE ACROSS CR9 ≈7 V?
NO
E OF Q15 ≈−2.4 V & E OF Q21 ≈+2.4 V?
YES
1
YES
E OF Q17 ≈+10 V?
NO
CHECK FOR DEFECTIVE Q17 & CR15
CHECK FOR DEFECTIVE TRANSISTORS Q15 TO Q21 & CAPACITORS
YES
∿ GEN O.K. SEE OTHER TABLES FOR ABNORMAL ∿
REPLACE DEFECTIVE IC10
REPLACE Q20 OR Q16
CHECK FOR DEFECTIVE Q15, Q18, Q19 & Q21
1
DISCONNECT THE SHORT AT GATE OF Q6
YES
∿ OUTPUT AT G OF Q7?
NO
VOLTAGE AT PINS 3 & 9 OF IC10 ≈3 V?
NO
Q16 SHOULD BE ON & Q20 OFF
YES
NO
WITH Q18 OFF, Q19 ON, E OF Q15 ≈−2.4 V, E OF Q21 ≈+2.4 V
NO
CHECK FOR DEFECTIVE CR14, CR16, Q16 & Q20
3
YES
YES
YES
NO
2
VOLTAGE AT G OF Q7 < 1.25 V?
YES
VOLTAGE AT B OF Q16 ≈0.7 V BELOW B OF Q20
NO
VOLTAGES ACROSS R111 ≈1 V, ACROSS R129 ≈0 V?
NO
CR8 IS SHORTED OR IC10 IS DEFECTIVE

Table 4-3. TRIANGLE AMPLIFIER, COMPARATOR, AND HYSTERESIS SWITCH (Continued)

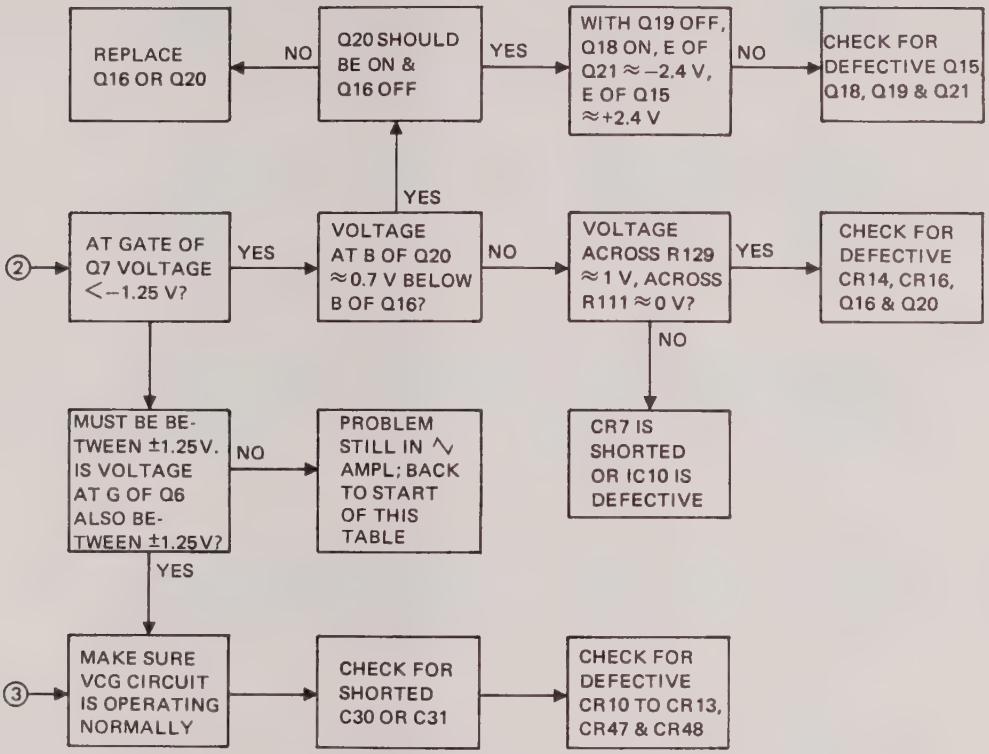

REPLACE Q16 OR Q20
NO
Q20 SHOULD BE ON & Q16 OFF
YES
WITH Q19 OFF, Q18 ON, E OF Q21 ≈ −2.4 V, E OF Q15 ≈ +2.4 V
NO
CHECK FOR DEFECTIVE Q15, Q18, Q19 & Q21
YES
2
AT GATE OF Q7 VOLTAGE < −1.25 V?
YES
VOLTAGE AT B OF Q20 ≈ 0.7 V BELOW B OF Q16?
NO
VOLTAGE ACROSS R129 ≈ 1 V, ACROSS R111 ≈ 0 V?
YES
CHECK FOR DEFECTIVE CR14, CR16, Q16 & Q20
NO
MUST BE BETWEEN ±1.25 V. IS VOLTAGE AT G OF Q6 ALSO BETWEEN ±1.25 V?
NO
PROBLEM STILL IN ∿ AMPL; BACK TO START OF THIS TABLE
CR7 IS SHORTED OR IC10 IS DEFECTIVE
YES
3
MAKE SURE VCG CIRCUIT IS OPERATING NORMALLY
CHECK FOR SHORTED C30 OR C31
CHECK FOR DEFECTIVE CR10 TO CR13, CR47 & CR48

Table 4-4. VCG, CURRENT SOURCE, AND TRIG BASE LINE CORRECTOR

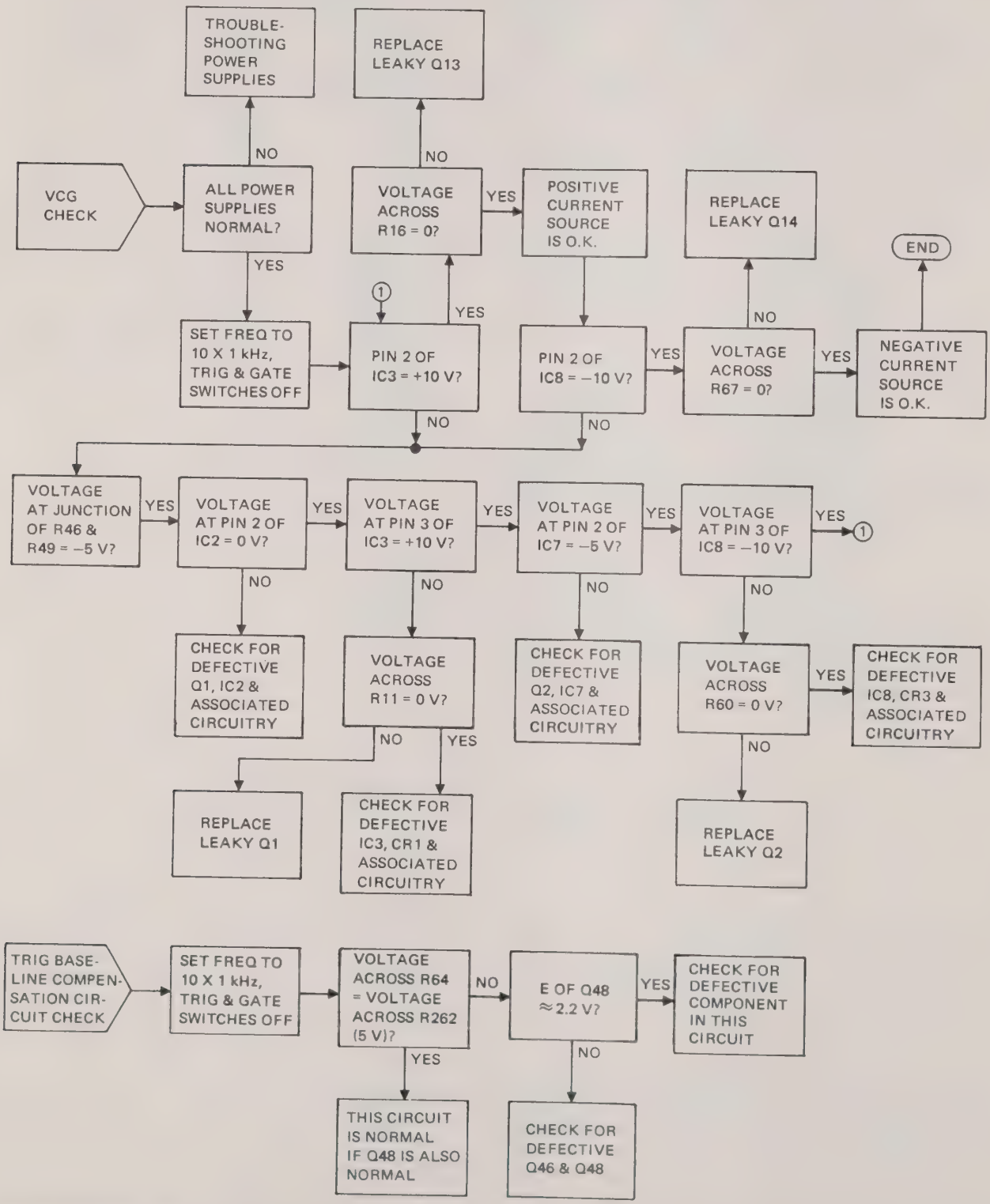


Table 4-5. OUTPUT AMPLIFIER

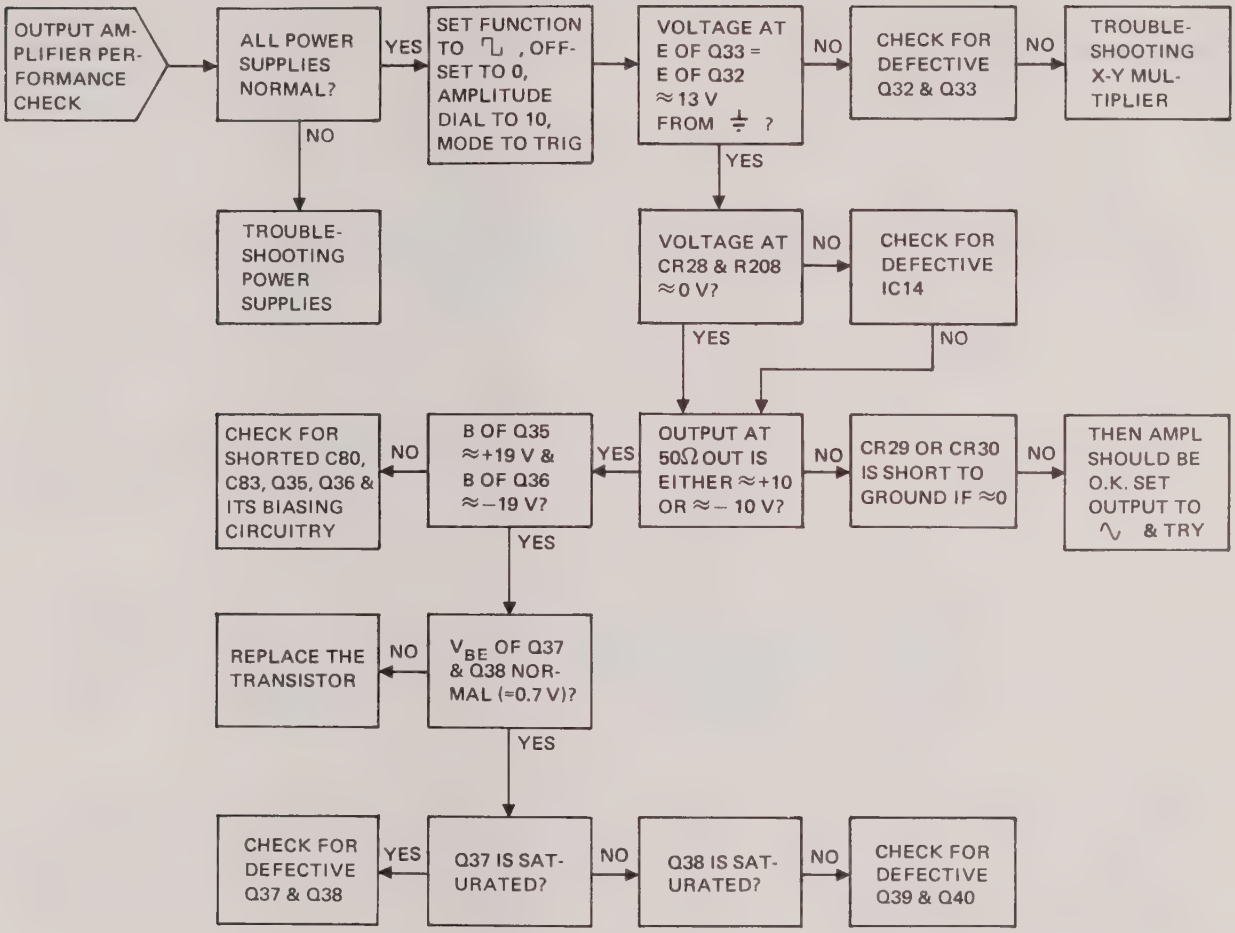

OUTPUT AMPLIFIER PERFORMANCE CHECK
ALL POWER SUPPLIES NORMAL?
YES
NO
TROUBLESHOOTING POWER SUPPLIES
SET FUNCTION TO ⎍ , OFFSET TO 0, AMPLITUDE DIAL TO 10, MODE TO TRIG
VOLTAGE AT E OF Q33 = E OF Q32 ≈13 V FROM ⏚ ?
NO
CHECK FOR DEFECTIVE Q32 & Q33
NO
TROUBLESHOOTING X-Y MULTIPLIER
YES
VOLTAGE AT CR28 & R208 ≈0 V?
NO
CHECK FOR DEFECTIVE IC14
YES
NO
OUTPUT AT 50Ω OUT IS EITHER ≈+10 OR ≈−10 V?
NO
CR29 OR CR30 IS SHORT TO GROUND IF ≈0
NO
THEN AMPL SHOULD BE O.K. SET OUTPUT TO ∿ & TRY
YES
B OF Q35 ≈+19 V & B OF Q36 ≈−19 V?
NO
CHECK FOR SHORTED C80, C83, Q35, Q36 & ITS BIASING CIRCUITRY
YES
V_{BE} OF Q37 & Q38 NORMAL (≈0.7 V)?
NO
REPLACE THE TRANSISTOR
YES
Q37 IS SATURATED?
NO
Q38 IS SATURATED?
NO
CHECK FOR DEFECTIVE Q39 & Q40
YES
CHECK FOR DEFECTIVE Q37 & Q38

Table 4-6. CAPACITANCE MULTIPLIER

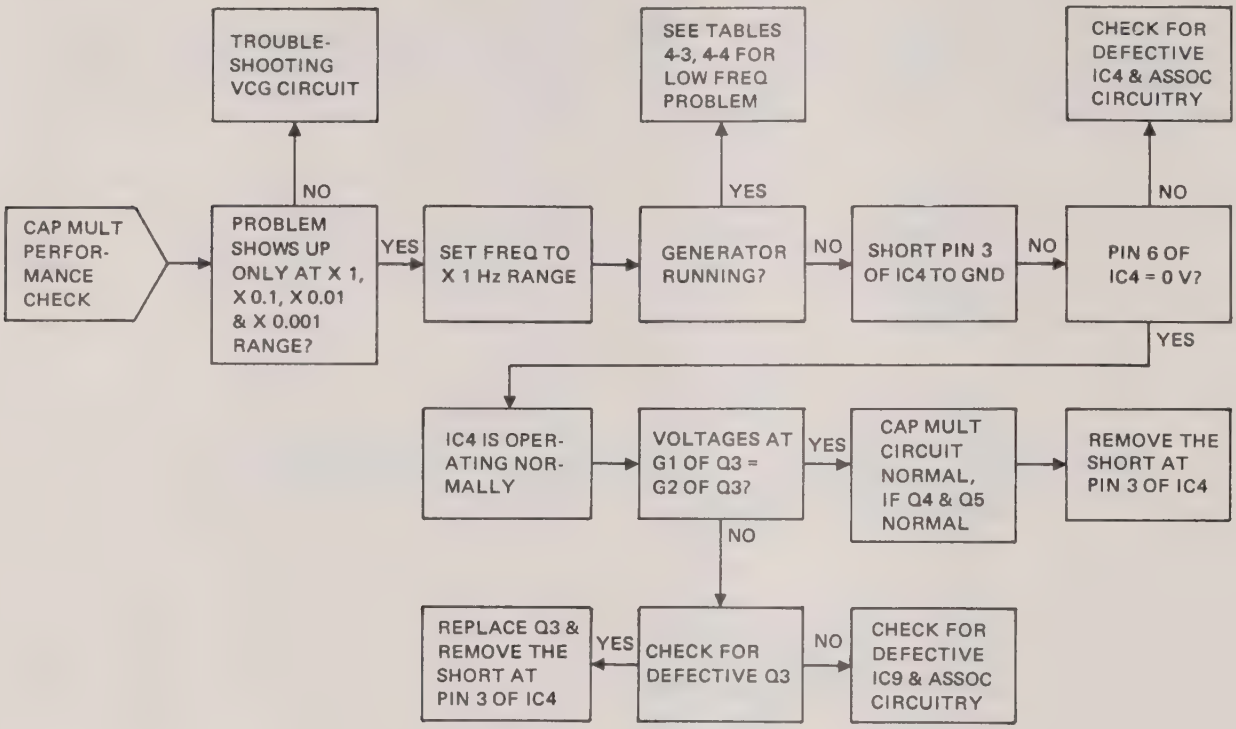

CAP MULT PERFOR-MANCE CHECK
PROBLEM SHOWS UP ONLY AT X 1, X 0.1, X 0.01 & X 0.001 RANGE?
NO
TROUBLE-SHOOTING VCG CIRCUIT
YES
SET FREQ TO X 1 Hz RANGE
GENERATOR RUNNING?
YES
SEE TABLES 4-3, 4-4 FOR LOW FREQ PROBLEM
NO
SHORT PIN 3 OF IC4 TO GND
PIN 6 OF IC4 = 0 V?
NO
CHECK FOR DEFECTIVE IC4 & ASSOC CIRCUITRY
YES
IC4 IS OPER-ATING NOR-MALLY
VOLTAGES AT G1 OF Q3 = G2 OF Q3?
YES
CAP MULT CIRCUIT NORMAL, IF Q4 & Q5 NORMAL
REMOVE THE SHORT AT PIN 3 OF IC4
NO
CHECK FOR DEFECTIVE Q3
YES
REPLACE Q3 & REMOVE THE SHORT AT PIN 3 OF IC4
NO
CHECK FOR DEFECTIVE IC9 & ASSOC CIRCUITRY

Table 4-7. AUXILIARY GENERATOR

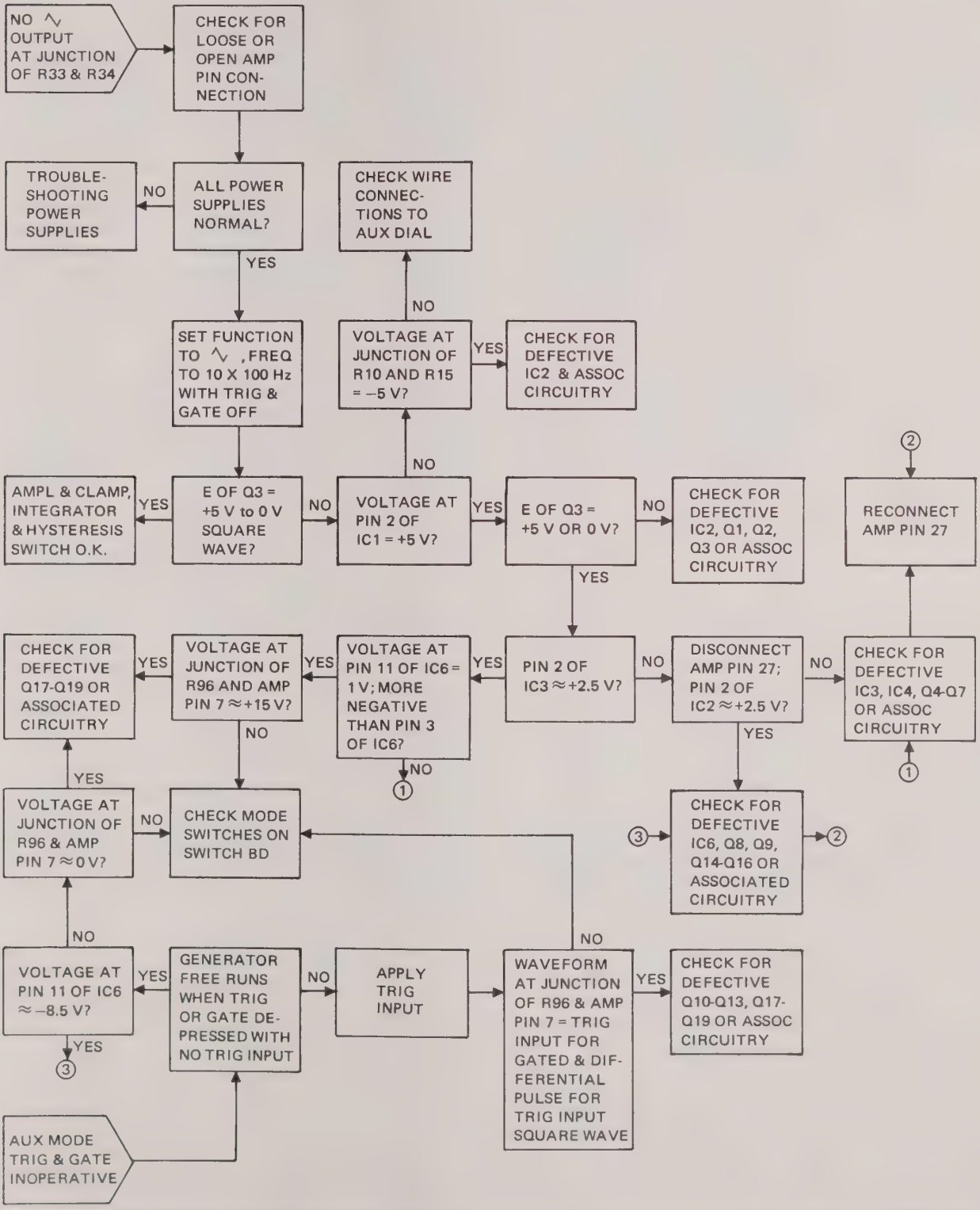
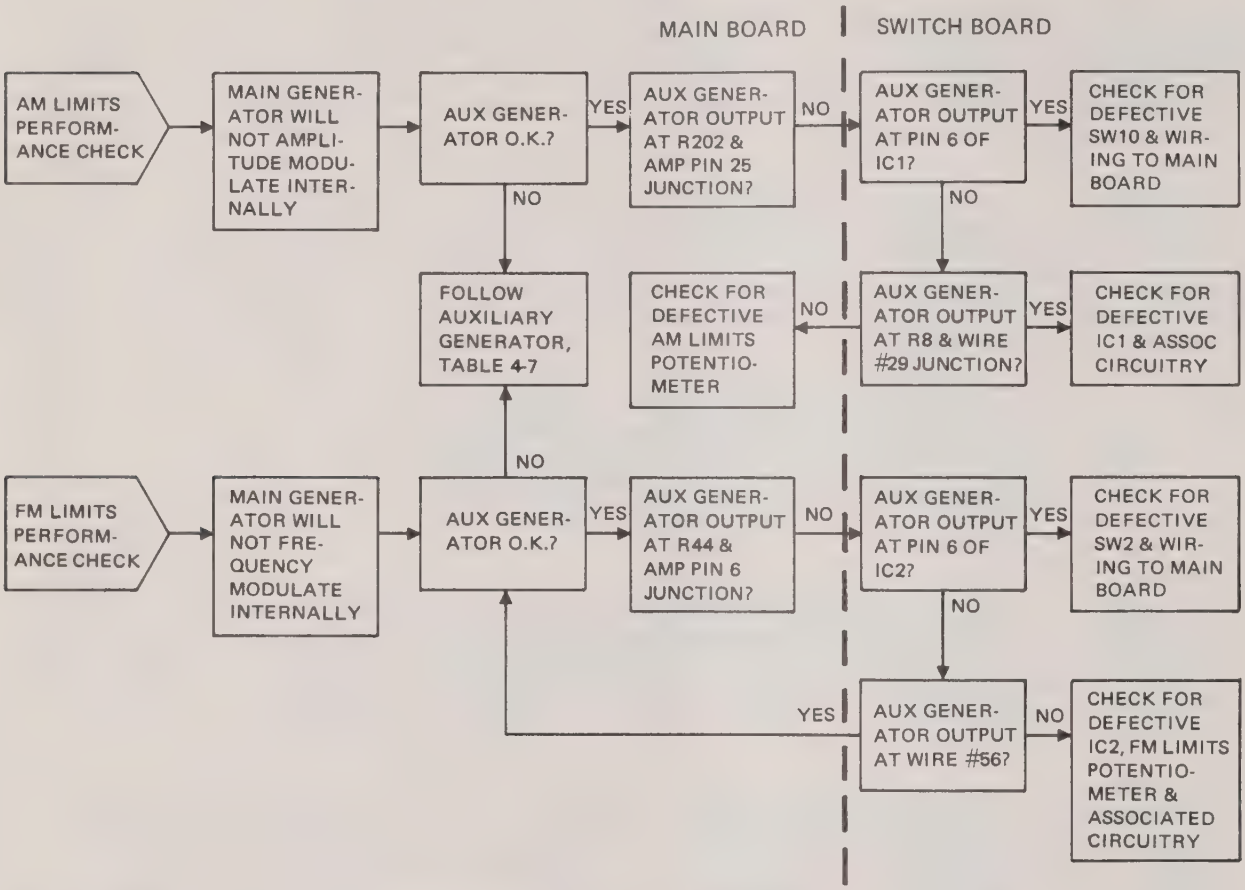

NO ∿ OUTPUT AT JUNCTION OF R33 & R34
CHECK FOR LOOSE OR OPEN AMP PIN CONNECTION
ALL POWER SUPPLIES NORMAL?
NO
TROUBLE-SHOOTING POWER SUPPLIES
YES
CHECK WIRE CONNECTIONS TO AUX DIAL
NO
VOLTAGE AT JUNCTION OF R10 AND R15 = −5 V?
YES
CHECK FOR DEFECTIVE IC2 & ASSOC CIRCUITRY
NO
SET FUNCTION TO ∿ , FREQ TO 10 X 100 Hz WITH TRIG & GATE OFF
E OF Q3 = +5 V to 0 V SQUARE WAVE?
NO
YES
AMPL & CLAMP, INTEGRATOR & HYSTERESIS SWITCH O.K.
YES
VOLTAGE AT PIN 2 OF IC1 = +5 V?
YES
NO
E OF Q3 = +5 V OR 0 V?
NO
CHECK FOR DEFECTIVE IC2, Q1, Q2, Q3 OR ASSOC CIRCUITRY
YES
2
RECONNECT AMP PIN 27
PIN 2 OF IC3 ≈ +2.5 V?
YES
NO
DISCONNECT AMP PIN 27; PIN 2 OF IC2 ≈ +2.5 V?
NO
YES
CHECK FOR DEFECTIVE IC3, IC4, Q4-Q7 OR ASSOC CIRCUITRY
1
VOLTAGE AT PIN 11 OF IC6 = 1 V; MORE NEGATIVE THAN PIN 3 OF IC6?
YES
NO
1
VOLTAGE AT JUNCTION OF R96 AND AMP PIN 7 ≈ +15 V?
YES
NO
CHECK FOR DEFECTIVE Q17-Q19 OR ASSOCIATED CIRCUITRY
YES
CHECK FOR DEFECTIVE IC6, Q8, Q9, Q14-Q16 OR ASSOCIATED CIRCUITRY
3
2
VOLTAGE AT JUNCTION OF R96 & AMP PIN 7 ≈ 0 V?
YES
NO
CHECK MODE SWITCHES ON SWITCH BD
NO
WAVEFORM AT JUNCTION OF R96 & AMP PIN 7 = TRIG INPUT FOR GATED & DIFFERENTIAL PULSE FOR TRIG INPUT SQUARE WAVE
YES
CHECK FOR DEFECTIVE Q10-Q13, Q17-Q19 OR ASSOC CIRCUITRY
APPLY TRIG INPUT
NO
GENERATOR FREE RUNS WHEN TRIG OR GATE DEPRESSED WITH NO TRIG INPUT
YES
VOLTAGE AT PIN 11 OF IC6 ≈ −8.5 V?
NO
YES
3
AUX MODE TRIG & GATE INOPERATIVE

Table 4-8. AM LIMITS AND FM LIMITS CONTROLS


MAIN BOARD
SWITCH BOARD
AM LIMITS PERFORM-ANCE CHECK
MAIN GENER-ATOR WILL NOT AMPLI-TUDE MODU-LATE INTER-NALLY
AUX GENER-ATOR O.K.?
YES
AUX GENER-ATOR OUTPUT AT R202 & AMP PIN 25 JUNCTION?
NO
AUX GENER-ATOR OUTPUT AT PIN 6 OF IC1?
YES
CHECK FOR DEFECTIVE SW10 & WIR-ING TO MAIN BOARD
NO
NO
FOLLOW AUXILIARY GENERATOR, TABLE 4-7
CHECK FOR DEFECTIVE AM LIMITS POTENTIO-METER
NO
AUX GENER-ATOR OUTPUT AT R8 & WIRE #29 JUNCTION?
YES
CHECK FOR DEFECTIVE IC1 & ASSOC CIRCUITRY
NO
FM LIMITS PERFORM-ANCE CHECK
MAIN GENER-ATOR WILL NOT FRE-QUENCY MODULATE INTERNALLY
AUX GENER-ATOR O.K.?
YES
AUX GENER-ATOR OUTPUT AT R44 & AMP PIN 6 JUNCTION?
NO
AUX GENER-ATOR OUTPUT AT PIN 6 OF IC2?
YES
CHECK FOR DEFECTIVE SW2 & WIR-ING TO MAIN BOARD
NO
YES
AUX GENER-ATOR OUTPUT AT WIRE #56?
NO
CHECK FOR DEFECTIVE IC2, FM LIMITS POTENTIO-METER & ASSOCIATED CIRCUITRY

4.5.2.2 TRIGGER AND GATED LOGIC TIMING

For trouble-shooting the trigger, set the generator to the GATE MODE. (Refer to Table 4-9.) Draw a vertical line on the timing diagram along t_1 or t_2, depending on whether the TRIG IN signal is low or high, and check for correct voltage levels according to the timing diagram.

After the GATE MODE has been checked, the TRIG MODE can be checked in the same way, but concentrated in the Q55, Q56 area.

Table 4-9. TRIGGER AND GATED LOGIC TIMING DIAGRAM

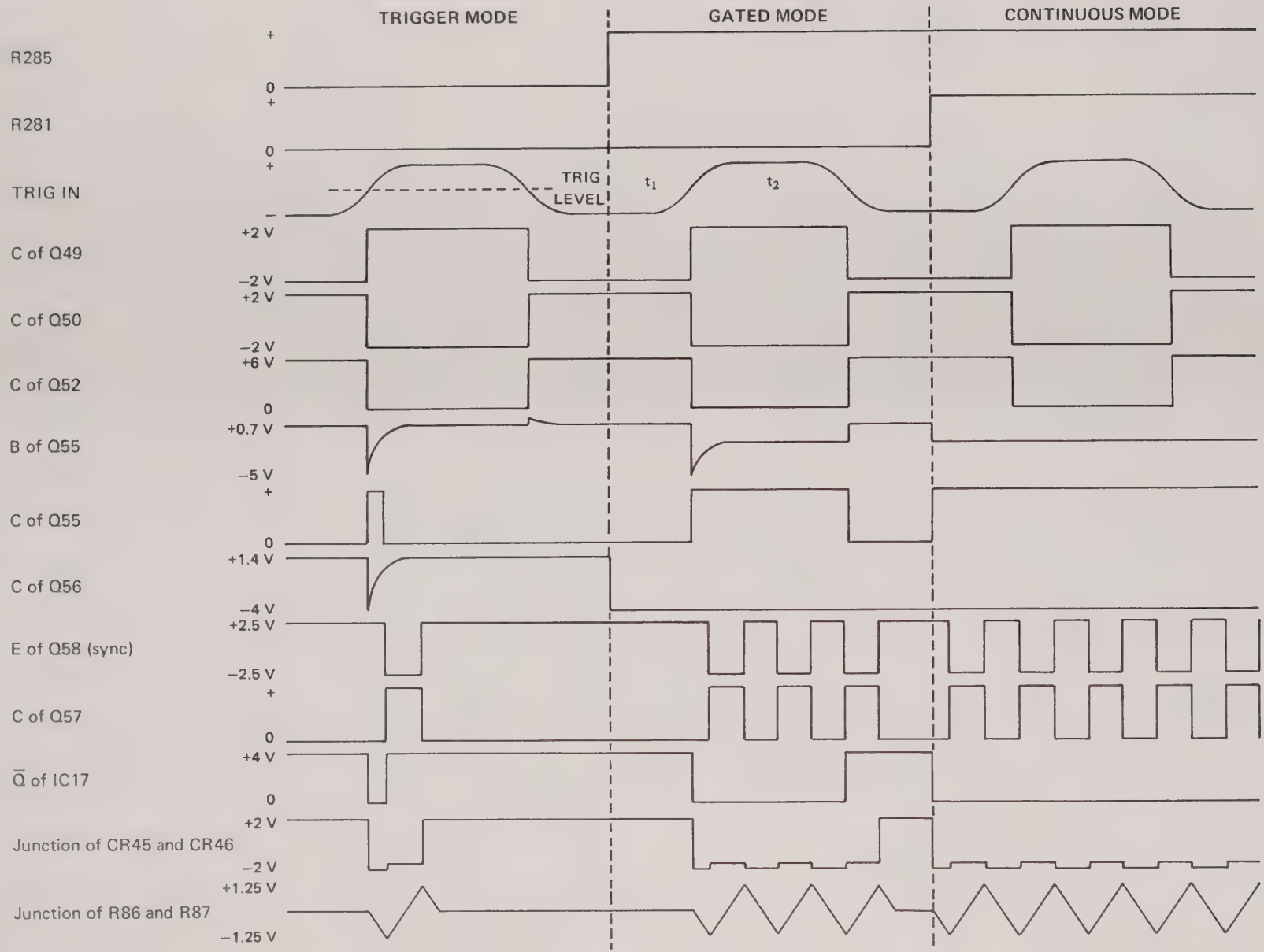


Table 4-10. KEY SIGNAL AND VOLTAGE

∿ AMPLIFIER, COMPARATOR AND HYSTERESIS SWITCH

Test Point	Typical Voltage
G of Q6	2.5 V p-p ∿ , 0 Vdc offset
G of Q7	2.5 V p-p ∿ , 0 Vdc offset
E of Q10	2.5 V p-p ∿ , ≈ +7 Vdc offset
Pins 1 and 4 of IC10	See Table 4-11.
Pins 2 and 8	−3 V
Pins 3 and 9	−3.7 V
E of Q16	+6.8 Vdc
B of Q16 and Q20	See Table 4-11.
E of Q15 and Q21	See Table 4-11.
E of Q17	+10 V
R118 and R125 junction	−3 V
S of Q13	+10 V to +15 V, dependent on frequency setting
S of Q14	−10 V to −15 V, dependent on frequency setting

X-Y MULTIPLIER

Test Point	Typical Voltage
R196	Selected signal (∿ , ∿ , ⊓⊔)
Pin 6 of IC11	+11 volts to −11 volts, dependent upon AMPLITUDE dial setting
Pin 6 of IC12	+2.5 volts to −2.5 volts, dependent upon AMPLITUDE dial setting
Pins 3 and 13 of IC13	−10.5 V
Pin 1 of IC13	Selected signal output +4 Vdc offset
E of Q32 and E of Q33	Selected signal output +13 Vdc offset amplitude dependent upon setting
Pin 14 of IC13	≈7 Vdc

∿ CONVERTER AND AMPLIFIER

Test Point	Typical Voltage
Pin 2 of A1	See Table 4-11.
Pin 4 of A1	+14 V
Pin 1 of A1	−14 V
Pin 5 of A1	250 mV p-p ∿ , 0 Vdc offset
R155 and R156 junction	2.5 V p-p ∿ , 0 Vdc offset
B of Q24 and Q25	+8 V

SYNC AND SQUARE AMPLIFIER

Test Point	Typical Voltage
R165 and R166 junction	±2 V ⊓⊔
CR23 cathode	±1.25 V ⊓⊔
R175 and R176 junction	±1.25 V ⊓⊔

OUTPUT AMPLIFIER

Test Point	Typical Voltage
B of Q35	+19 Vdc
E of Q37	+19 Vdc
B of Q36	−19 Vdc
E of Q38	−19 Vdc
R238 and R241 junction	Main output, ±10 V maximum

VCG AMPLIFIER AND TRIGGER BASELINE COMPENSATION

Test Point	Typical Voltage
Pin 6 of IC1	0 V to +5 V*
R46 and R49 junction	0 V to −5 V*
S of Q1	0 V
Pins 2 and 3 of IC3	+10 V to +15 V*
S of Q2	0 V to −5 V*
Pins 2 and 3 of IC7	−10 V to −15 V*
V_{GS} of Q46	$V_{G1,S1} = V_{G2,S2}$
R258 and R260	Voltage across both are equal
E of Q48	+2.2 V
R262	Voltage across R262 and R64 are equal

*Voltage is dependent on a FREQUENCY dial setting.

CAPACITANCE MULTIPLIER*

Test Point	Typical Voltage
G1 and G2 of Q3	±1.25 V ∿
Pin 6 of IC9	⊓⊔ , amplitude dependent on frequency setting
Pins 2 and 3 of IC4	±1.25 V ∿
Pin 6 of IC4	±7.5 V ∿

*The information applies if the frequency range is at X 1 Hz.

AUXILIARY GENERATOR
(CONT MODE)

KEY SIGNALS AND VOLTAGES

Test Point	Typical Voltage
Pin 6 of IC2	0 V to +5 Vdc dependent on FREQUENCY dial setting
Pin 6 of IC1	0 Vdc
E of Q3	0 V to +5 Vdc step source dependent on FREQUENCY dial setting (see Figure 3-7 for correct step source).
Pin 13 of IC4	+1.25 Vdc
Pin 9 of IC4	−1.25 Vdc
C of Q6, pin 11 of IC4, pin 3 of IC1 and pin 3 of IC7	1 V p-p logic level, ≈ −3 Vdc offset 180° out-of-phase with logic level of C of Q7
C of Q7, pin 3 of IC4, pin 11 of IC1 and pin 11 of IC7	1 V p-p logic level, ≈ −3 Vdc offset 180° out-of-phase with logic level of C of Q6
Pin 3 of IC6	−7.5 Vdc
Pin 11 of IC6	−6.5 Vdc
R96 and AMP pin 7 junction	+15 Vdc
Pin 2 of IC7	+2.5 Vdc
Pin 6 of IC7	−2.5 Vdc
Pin 4 of IC5	±125 mV ∿
Pin 12 of IC5	±2.5 V ∿

∿ ∿ ⊓ FUNCTIONS ONLY

Test Point	Typical Voltage
Pin 2 of IC3, R20 and AMP pin 27 junction, and pin 6 of IC6	≈ +2.5 V
R33 and R34 junction	±2.5 V ∿
E of Q22 and AUX OUT connector	±2.5 V ⊓

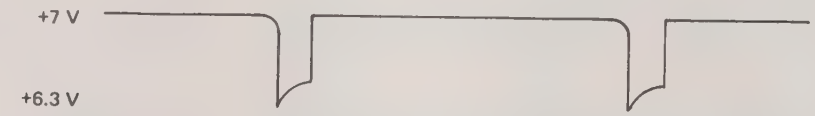
FUNCTION ONLY

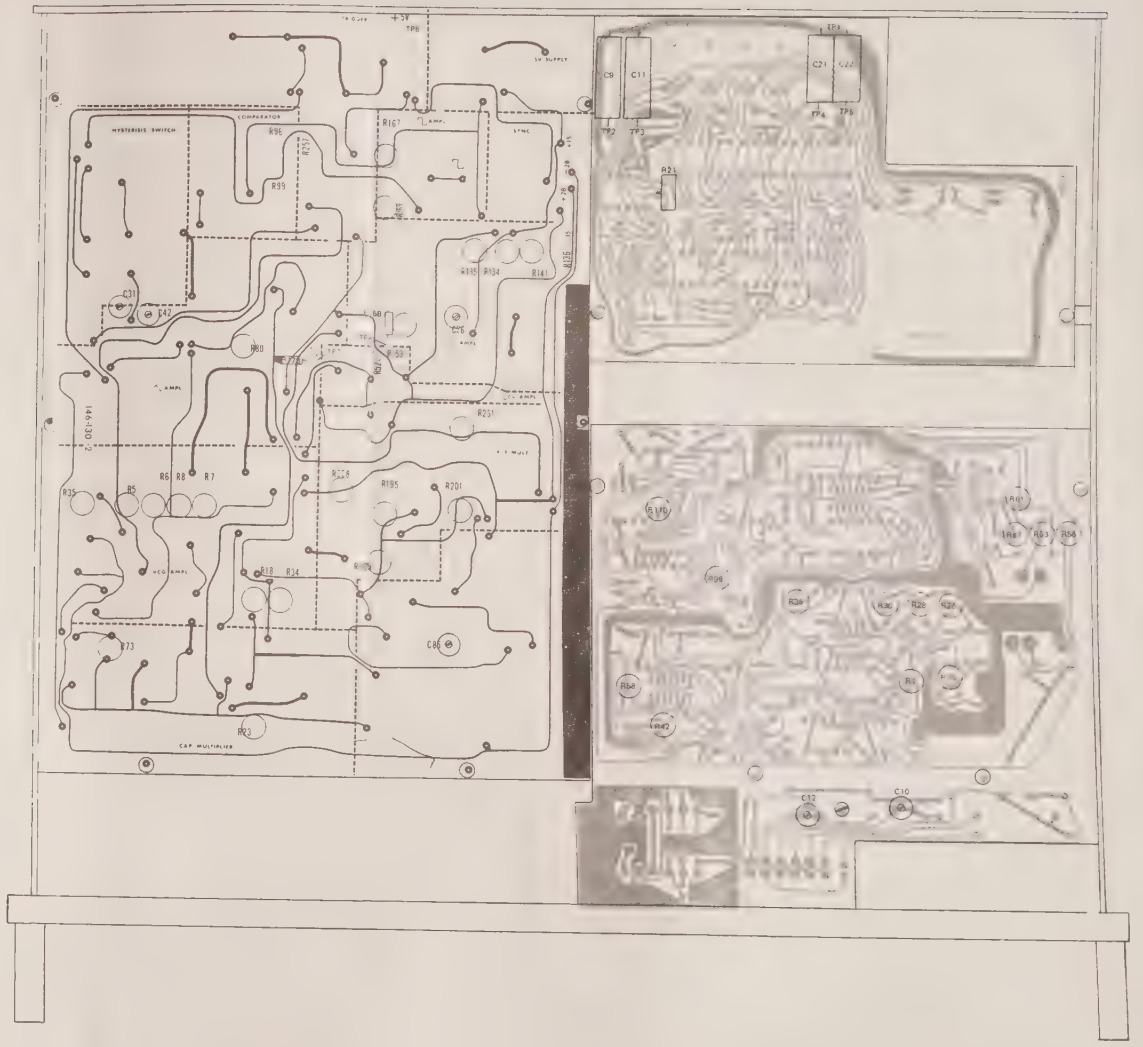
Test Point	Typical Voltage
Pin 2 of IC3, R20 and AMP pin 27 junction, and pin 6 of IC6	≈ +0.1 V
R33 and R34 junction	±2.5 V
E of Q22 and AUX OUT connector	±2.5 V ⊔

FUNCTION ONLY

Test Point	Typical Voltage
Pin 2 of IC3, R20 and AMP pin 27 junction, and pin 6 of IC6	+4.9 V
R33 and R34 junction	±2.5 V
E of Q22 and AUX OUT connector	±2.5 V ⊓

Table 4-11. KEY WAVEFORMS

Test Point	Waveforms
G of Q6 G of Q7	
Pin 1 of IC10	
Pin 4 of IC10	
B of Q16	
B of Q20	
E of Q15	
E of Q21	
CR12 Anode	
CR13 Cathode	
P2 of A1	
P5 of A1	
R155 and R156	


+5V
TP6
5V SUPPLY
COMPARATOR
HYSTERESIS SWITCH
R96
R99
R167
SYNC
C31
R40
R80
R59
R251
R195
R201
R18
R34
R73
R93
C86
CAP MULTIPLIER
C9
C11
TP2
TP3
C21
TP4
TP5
R21
R5
R6
R8
R7
R35
R36
R37
R38
R39
R41
R42
R43
R44
C12
C10

SECTION 5
DIAGRAMS ADDENDUMS AND PARTS LISTS

5.1 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

5.2 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit and, if applicable, the function performed.

5.3 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

CROSS REFERENCE FOR DRAWING NUMBERS

Drawings	Old Number	New Number
Chassis Assy	146-020	0102-00-0296
Chassis Schematic	146-220	0004-00-0037
Chassis Parts List	*	1101-00-0037
Main Board Assy	146-030	0101-00-0056
Main Board Schematic	146-230	0103-00-0056
Main Board Parts List	*	1100-00-0056
Power Supply Assy	146-011	0101-00-0057
Power Supply Schematic	146-211	0103-00-0057
Power Supply Parts List	*	1100-00-0057
Movement Assy	146-002	0102-00-0329
Left Movement Parts List	*	1101-00-0070
Right Movement Parts List	*	1101-00-0091
Switch Board Assy	146-032	0101-00-0058
Switch Board Schematic	146-232	0103-00-0058
Switch Board Parts List	*	1100-00-0058
Auxiliary Board Assy	146-033	0101-00-0059
Auxiliary Board Schematic	146-233	0103-00-0059
Auxiliary Board Parts List	*	1100-00-0059
Rear Panel Assy	146-014	0102-00-0330
Rear Panel Parts List	*	1101-00-0071
Trigger Switch Assy	146-005	1202-00-0015
Trigger Switch Parts List	*	*
Freq Hz Switch Assy	146-006	1202-00-0016
Freq Hz Switch Parts List	*	*
Attenuator Switch Assy	146-007	1202-00-0017
Attenuator Switch Parts List	*	*
D/C Offset Switch Assy	146-008	1202-00-0018
D/C Offset Switch Parts List	*	*
Freq/Period Switch Assy	146-009	1202-00-0019
Freq/Period Switch Parts List	*	*
Patch Block Assy	154-024	1205-00-0489
Patch Block Parts List	*	*

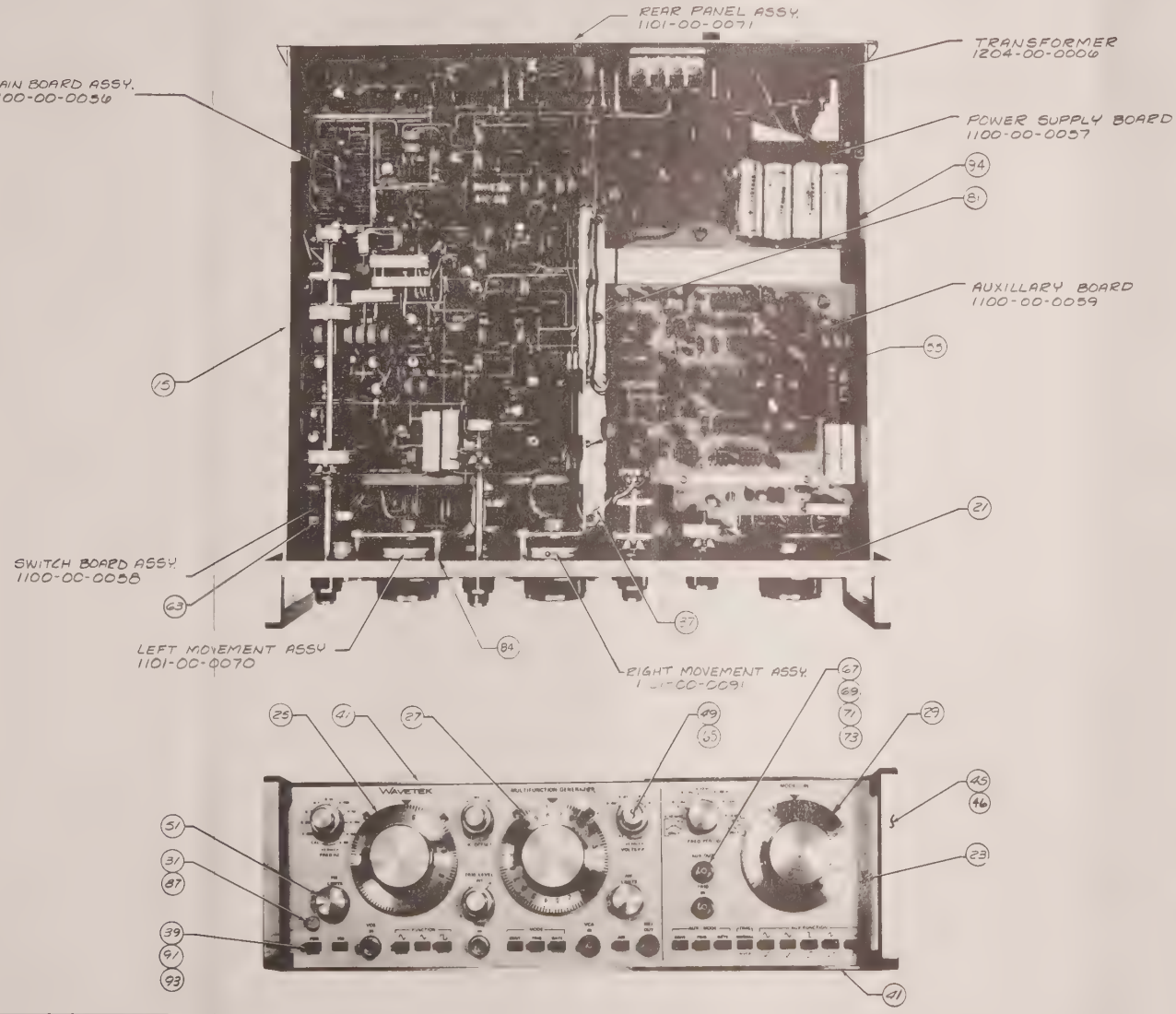
*Same as assembly number

5.4 RECOMMENDED SPARE PARTS LIST

Information is provided to maintain the instrument on a board or component level. Price and delivery information should be obtained from the Wavetek representative in your area or directly from the factory.

DESCRIPTION	MFG	PART NO.	QTY
BOARD LEVEL			
MAIN BOARD	WAVETEK	146-030	1
POWER SUPPLY BOARD	WAVETEK	146-011	1
SWITCH BOARD	WAVETEK	146-032	1
AUXILIARY GENERATOR BOARD	WAVETEK	146-033	1
COMPONENT LEVEL			
DIODE	SEMTECH	SCE-1	2
DIODE	FAIRCHILD	FD777	1
DIODE	FAIRCHILD	FD6666	2
DIODE TUNNEL	GE	1N3716	1
DIODE ZENER	WAVETEK	1N4581	2
FUSE ¼A 230 V	LITTELFUSE	313-250	1
FUSE ½A 115 V	LITTELFUSE	313-500	
★INTEGRATED CKT – 13	FAIRCHILD	μA709C	2
★INTEGRATED CKT – 14	RCA	CA3054	1
★INTEGRATED CKT – 15	RCA	CA3030	1
INTEGRATED CKT	RCA	CA3028A	1
INTEGRATED CKT	RCA	CA3049	1
INTEGRATED CKT	FAIRCHILD	μA795	1
INTEGRATED CKT	NATIONAL	LM-301AN	1
INTEGRATED CKT	MOTOROLA	MC3050P	1
LAMP	MURA	L 28/40	1
SINE MODULE	WAVETEK	B142-011	1
TRANSISTOR	MOTOROLA	2N2905A	1
TRANSISTOR	FAIRCHILD	2N3638	2
TRANSISTOR	FAIRCHILD	2N3640	1
TRANSISTOR	FAIRCHILD	2N3642	2
TRANSISTOR	FAIRCHILD	2N3646	2
TRANSISTOR	MOTOROLA	2N3903	1
TRANSISTOR	MOTOROLA	2N3905	1
TRANSISTOR	FAIRCHILD	2N4047	1
TRANSISTOR	FAIRCHILD	2N4248	1
TRANSISTOR	FAIRCHILD	2N5139	1
TRANSISTOR	MOTOROLA	2N5160	1
★TRANSISTOR – 52	MOTOROLA	2N3563	2
★TRANSISTOR – 53	MOTOROLA	2N5485	2
★TRANSISTOR – 54	MOTOROLA	2N5485	1
★TRANSISTOR – 55	MOTOROLA	2N5462	1
★TRANSISTOR – 66	MOTOROLA	2N2219A	1
TRANSISTOR	MOTOROLA	MPS L08	1
TRANSISTOR	TEXAS INST	TIP 29	1
TRANSISTOR	TEXAS INST	TIP 30	1
TRANSISTOR	TECH PROD	TP 308	1

★Denotes special selected parts and should be ordered from Wavetek.



E	ECN 1764	LN	3-23	
D	ECN 1482	RD	9-25-96	
C	ECN 1335	RD	8-5-96	
B	ECN 1060	RD	4-24-96	
A	ECN 951	RD	4-24-96	

tolerance unless otherwise specified	rev	ecn	by	date	appd
XXX ± .010 XX ± .030	WAVETEK san diego, calif				
scale –	by R. EDMAN	date 3-4-96	appd		
material –	title CHASSIS ASSY				
finish –	model no 146	dwg no 0102-00-0296	rev E		

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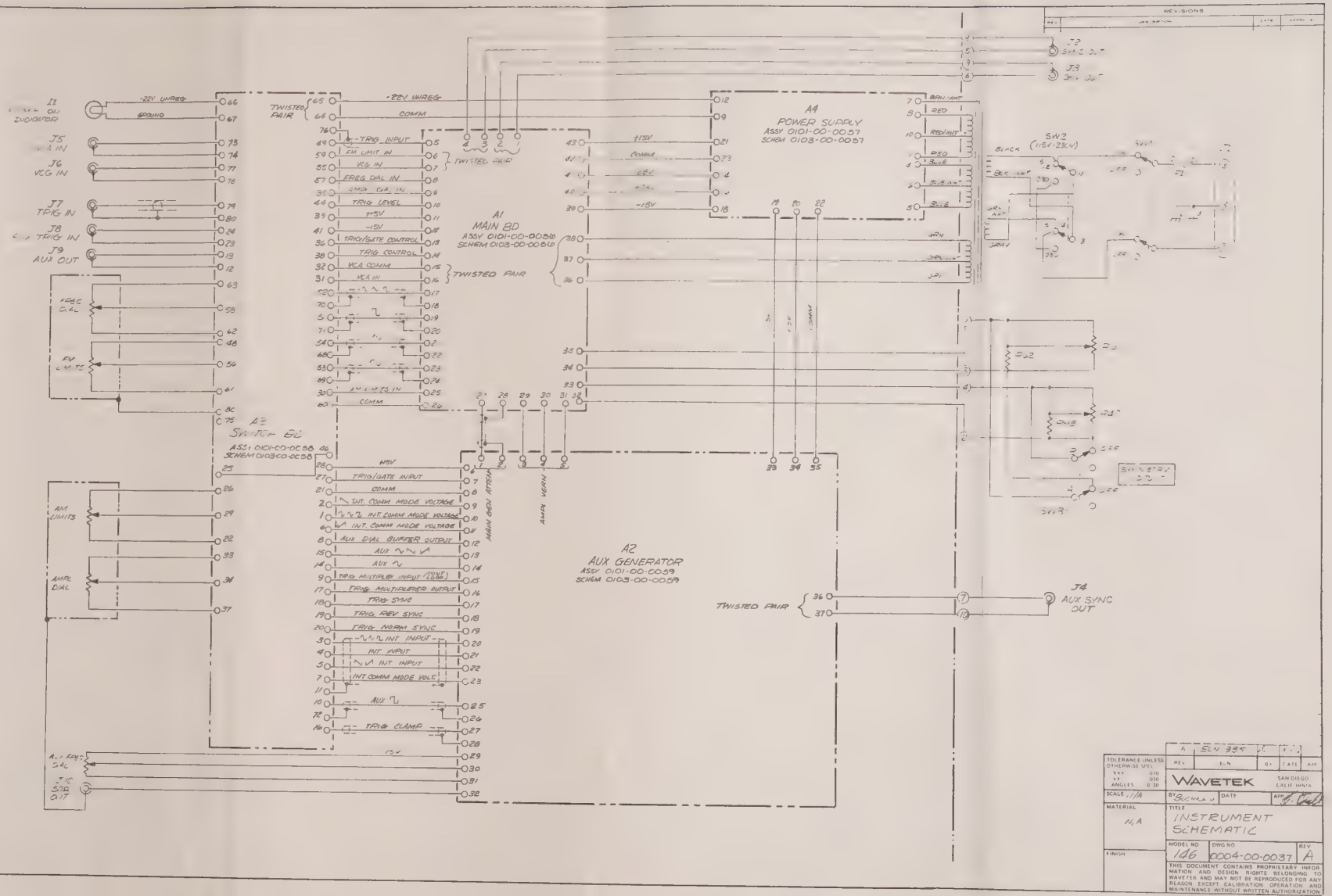
REVISIONS
A1
MAIN BD
ASSY 0101-00-0056
SCHEM 0103-00-0056
A2
AUX GENERATOR
ASSY. 0101-00-0059
SCHEM 0103-00-0059
A3
SWITCH BD
ASSY 0101-00-0058
SCHEM 0103-00-0058
A4
POWER SUPPLY
ASSY. 0101-00-0057
SCHEM 0103-00-0057
SW2
(115V-230V)
J2
SYNC OUT
J3
SYNC OUT
J4
AUX SYNC OUT
J5
J6
VCG IN
J7
TRIG IN
J8
TRIG IN
J9
AUX OUT
-22V UNREG
GROUND
TWISTED PAIR
COMM
TRIG INPUT
FM LIMIT IN
VCG IN
FREQ DIAL IN
AMPL DIAL IN
TRIG LEVEL
+15V
-15V
TRIG/GATE CONTROL
TRIG CONTROL
VCA COMM
VCA IN
FM LIMITS IN
COMM
+15V
COMM
-15V
TWISTED PAIR
TWISTED PAIR
FREQ DIAL
FM LIMITS
AM LIMITS
AMPL DIAL
+15V
TRIG/GATE INPUT
COMM
INT. COMM MODE VOLTAGE
INT. COMM MODE VOLTAGE
INT. COMM MODE VOLTAGE
AUX DIAL BUFFER OUTPUT
AUX
AUX
TRIG MULTIPLIER INPUT (SINE)
TRIG MULTIPLIER OUTPUT
TRIG SYNC
TRIG REV SYNC
TRIG NORM SYNC
INT. INPUT
INT. INPUT
INT. INPUT
INT COMM MODE VOLT
AUX
TRIG CLAMP
-15V
AMPL GEN ATTEN
AMPL VERN
TWISTED PAIR
BRN/WHT
RED
RED/WHT
RED
BLUE
BLU/WHT
BLUE
BLACK
SYNC OUT
AUX OUT
SYNC OUT
SYNC OUT
SW1
SW3
TOLERANCE UNLESS OTHERWISE SPEC
WAVETEK
SAN DIEGO CALIF. INVA
SCALE 1/1A
MATERIAL N/A
FINISH
TITLE INSTRUMENT SCHEMATIC
MODEL NO. 146
DWG NO. 0004-00-0037
REV. A
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REFERENCE DESIGNATIONS	PART DESCRIPTION	UNIQUE/CHARACTERISTIC	MFGR	MFGR'S PART NO.	QTY
A1	ASSY, UNMOD CHASSIS	010-[illegible]	WT	[illegible]	
A2	DIAL ASSY	130-[illegible]	WT	[illegible]	
A3	DIAL ASSY	130-[illegible]	WT	[illegible]	
A4	DIAL ASSY	130-[illegible]	WT	[illegible]	
A5	COVER ASSY	[illegible] ASSY	WT	[illegible]	
A6	BRKT,BUMP	[illegible]	WT	[illegible]	
A7	[illegible]	[illegible]	WT	[illegible]	
A8	BRKT,BR	[illegible]	WT	[illegible]	
	PANEL,SUB	[illegible]	WT	[illegible]	
	PLATE,BLDG	[illegible]	WT	[illegible]	
	PANEL,FT	[illegible]	WT	[illegible]	
	BRK,BUMP	[illegible]	WT	[illegible]	
A9	BLOCK,SPACER	[illegible]	WT	[illegible]	
A10	LENS,INDICATOR	[illegible]	WT	[illegible]	
	KNOB	[illegible]	WT	[illegible]	
A11 thru A14	MODULE,M/A PROM[illegible]	[illegible]	WT	[illegible]	
A15	CLAMP	[illegible]	WT	[illegible]	

WAVETEK PARTS LIST

TITLE STD CHASSIS

ASSEMBLY NO [illegible]

REV [illegible]

PAGE 1

REFERENCE DESIGNATIONS	PART DESCRIPTION	UNIQUE/CHARACTERISTIC	MFGR	MFGR'S PART NO.	QTY

WAVETEK PARTS LIST

TITLE [illegible]

ASSEMBLY NO [illegible]

REV [illegible]

PAGE 2

REFERENCE DESIGNATIONS	PART DESCRIPTION	UNIQUE/CHARACTERISTIC	MFGR	MFGR'S PART NO.	QTY
A16	SWITCH,MODULE PROTECTION	[illegible]	WT	[illegible]	
A17	SWITCH PROTECTION	[illegible]	WT	[illegible]	
P1	REAR CONN	[illegible]	AMP	[illegible]	
J1	BOARD CONN	[illegible]	AMP	[illegible]	
A1	BIG KNOB	[illegible]	MCDAN	[illegible]	
A2	LOAD KNOB ASY	[illegible]	MCDAN	[illegible]	
A3	[illegible]	[illegible]	MCDAN	[illegible]	
A4	BRACKET	[illegible]	AMP	[illegible]	
A5	BRACKET	[illegible]	AMP	[illegible]	
[illegible]	BRACKET	[illegible]	AMP	[illegible]	
[illegible]	[illegible]	[illegible]	AMP	[illegible]	
[illegible]	[illegible]	[illegible]	BURTON	[illegible]	
[illegible]	PART,CHASSIS	[illegible]	BURTON	[illegible]	
A6	[illegible]	[illegible]	AMP	[illegible]	
A7	[illegible]	[illegible]	AMP	[illegible]	
A8	MTGHW PLAT ASSMBLY	[illegible]	AMP	[illegible]	
A9	RETAINING RING	[illegible]	TRUMP	[illegible]	

WAVETEK PARTS LIST

TITLE STD CHASSIS

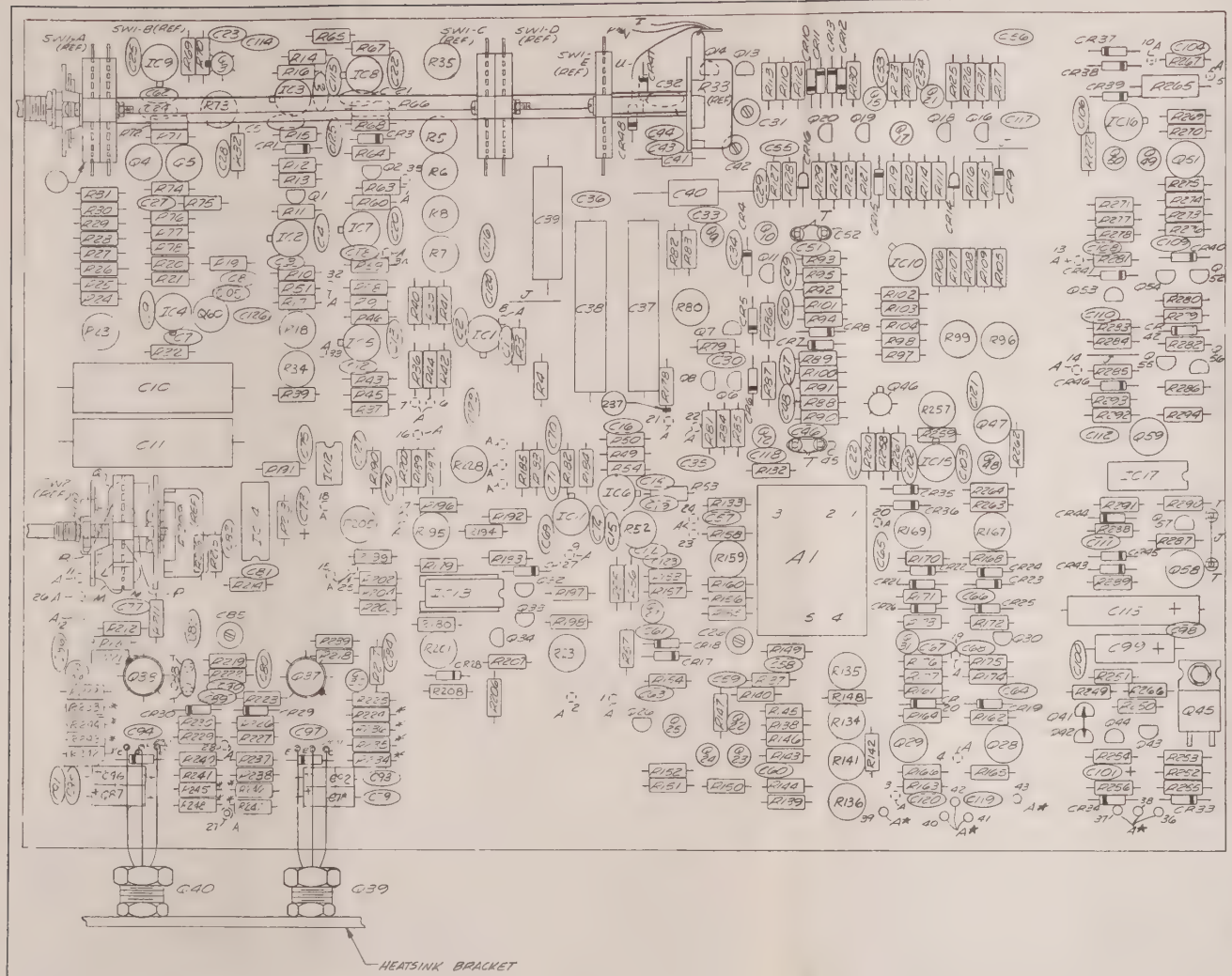
ASSEMBLY NO 1101-00-0037

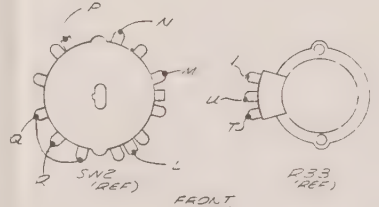
REV E

PAGE 3

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK
MATERIAL	DIRECTIONS		
	AS PER APPROV		TITLE STD CHASSIS
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX .010 ANGLES 1° .X .05		
	APPROVED		MODEL NO DRAWING 146-000 1101-00-0037 REV E
	DATE		SHEET 23328 SHEET OF





3. INSTALL CBB ON BIFURCATED TERMINALS (20008I)
2 * INDICATE RESISTOR WITH CRIMPED LEADS, TO BE MOUNTED OFF BOARD SURFACE (12)
1. A* INDICATES AMP PINS MOUNTED ON COMPONENT SIDE
NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
F	ECN 394		
E	ECN 337		
D	ECN 211		
C	1057		
B	920		
A	ECN 197		

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'

SCALE 2/1

MATERIAL —

FINISH —

WAVETEK SAN DIEGO CALIFORNIA

BY RSDUNN DATE 9-14-73 APP

TITLE ASSY MAIN BOARD

MODEL NO 146 DWG NO 0101-00-00510 SHEET 1 OF 1 REV F

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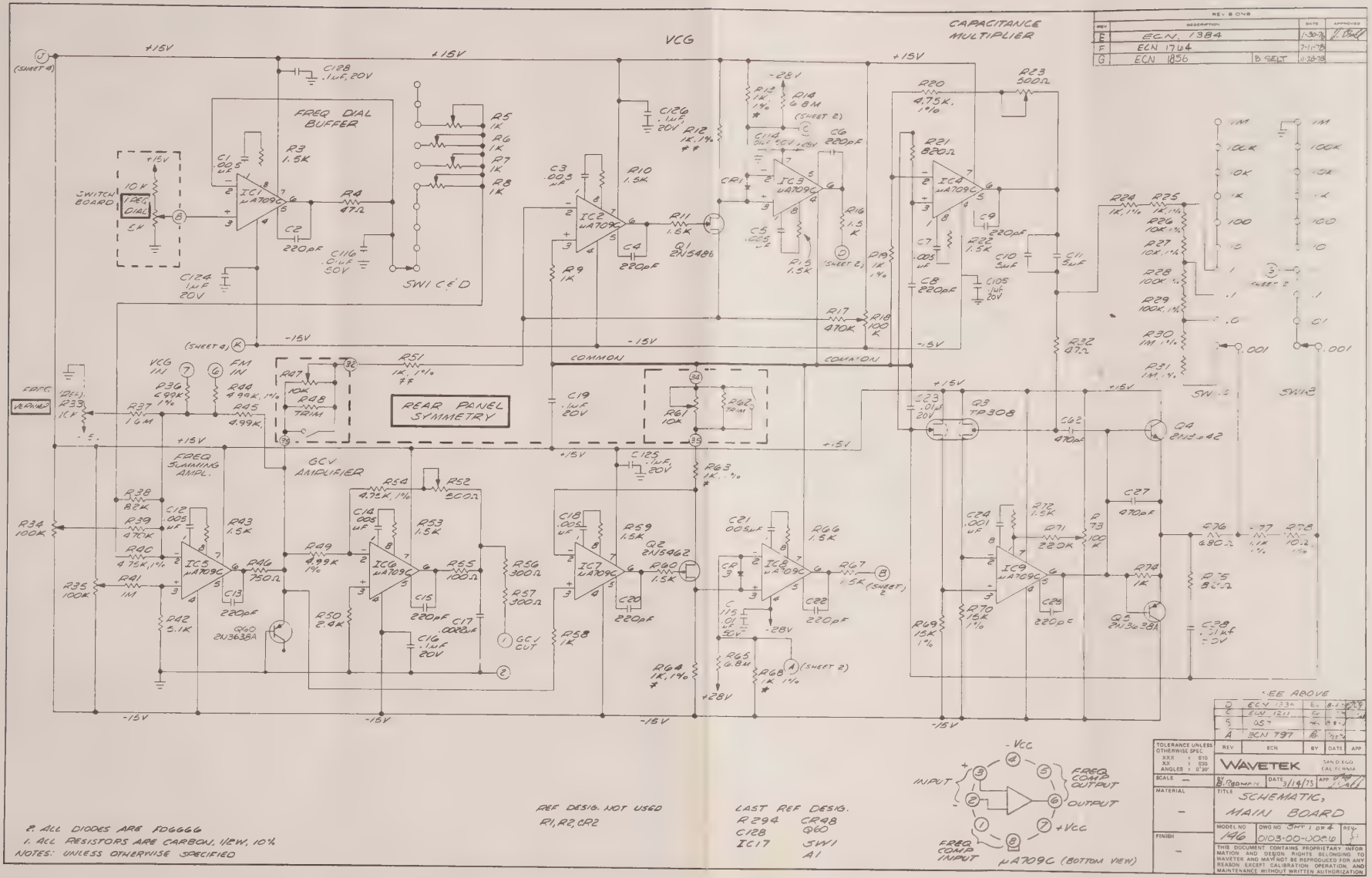
VCG
CAPACITANCE MULTIPLIER
FREQ DIAL BUFFER
SWITCHED
REAR PANEL SYMMETRY
FREQ SLAMMING AMPL.
GCV AMPLIFIER
COMMON
SW1-A
SW1-B
Q3 TP308
Q4 2N3642
Q5 2N3638A
Q60 2N3638A
Q1 2N5486
Q2 2N5962
+15V
-15V
+28V
-28V
REF DESIG. NOT USED
R1, R2, CR2
LAST REF DESIG.
R294 CR48
C128 Q60
IC17 SW1
A1
- Vcc
INPUT
FREQ COMP OUTPUT
OUTPUT
+Vcc
FREQ COMP INPUT
μA709C (BOTTOM VIEW)
2. ALL DIODES ARE FDG666
1. ALL RESISTORS ARE CARBON, 1/2W, 10%
NOTES: UNLESS OTHERWISE SPECIFIED
SEE ABOVE
TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'
SCALE —
MATERIAL —
FINISH —
WAVETEK
SAN DIEGO CAL FORNIA
SCHEMATIC, MAIN BOARD
MODEL NO 146
DWG NO 0103-00-00 REV G
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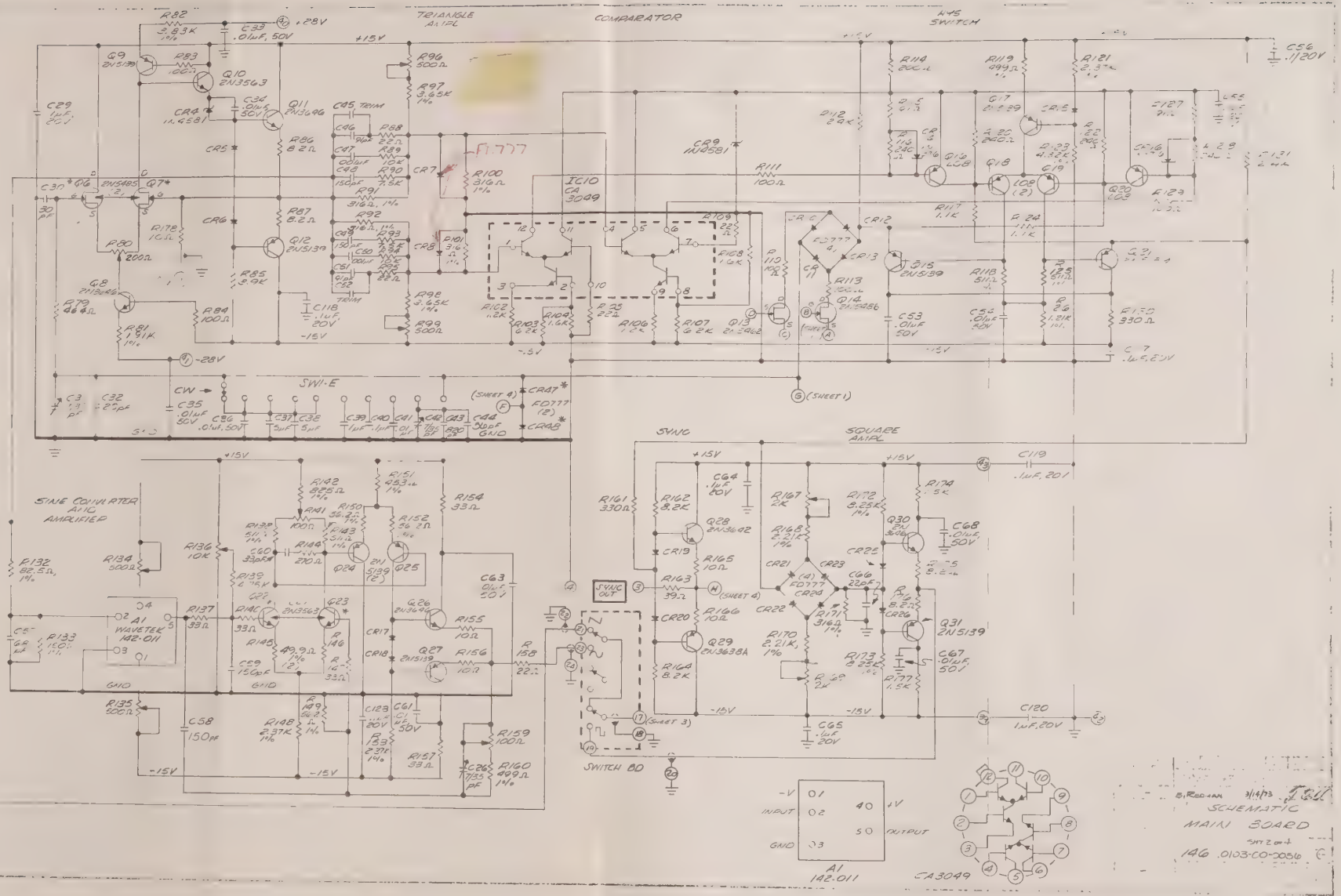
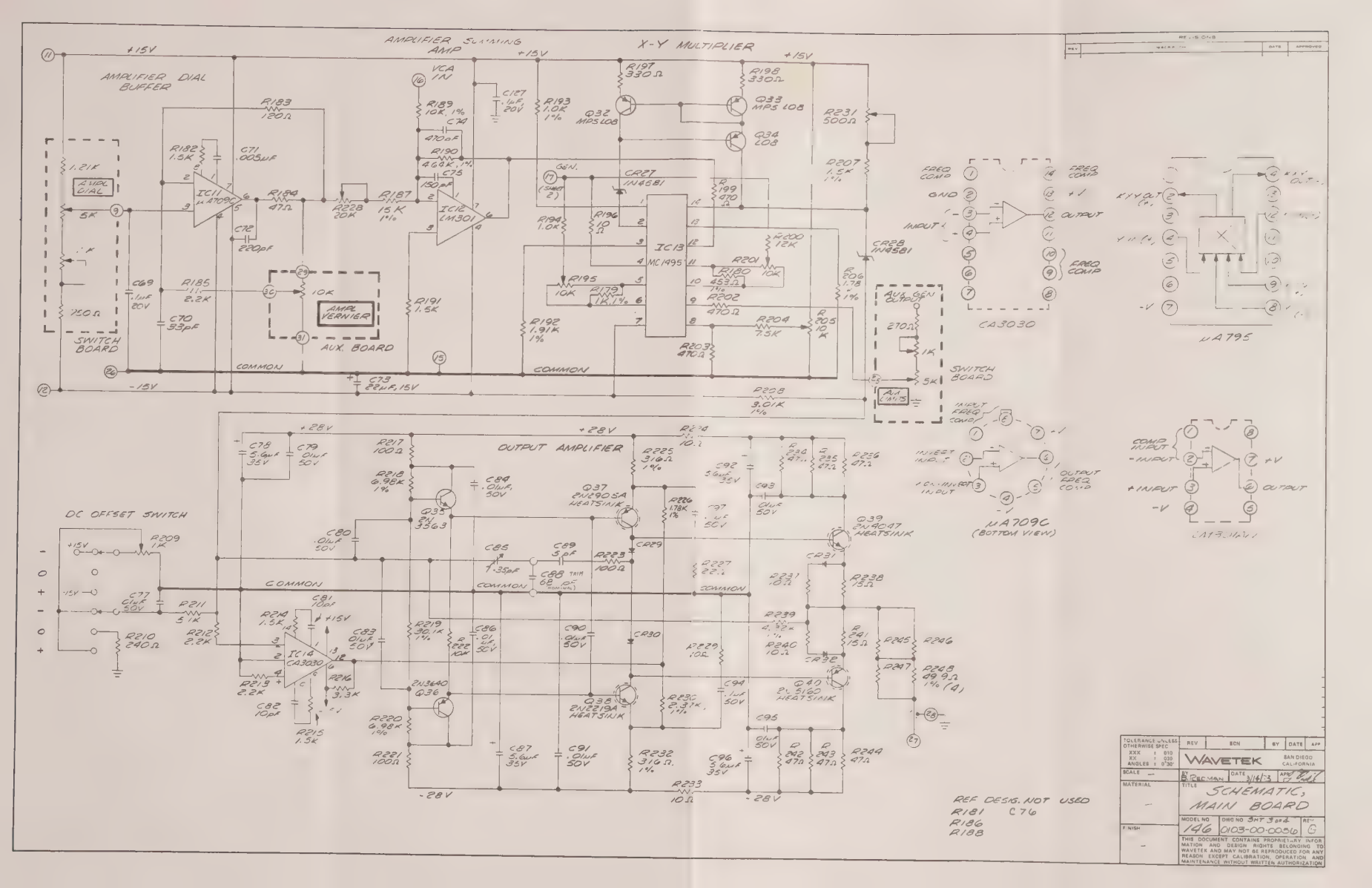

TRIANGLE AMPL
COMPARATOR
H45 SWITCH
SYNC
SQUARE AMPL
SINE CONVERTER AND AMPLIFIER
SWI-E
SWITCH BD
SYNC OUT
+15V
-15V
GND
A1 WAVETEK 142-011
CA3049
SCHEMATIC
MAIN BOARD
146-0103-CO-20516


AMPLIFIER DIAL BUFFER
AMPLIFIER SUMMING AMP
X-Y MULTIPLIER
OUTPUT AMPLIFIER
DC OFFSET SWITCH
SWITCH BOARD
AUX. BOARD
AMPL VERNIER
COMMON
+15V
-15V
+28V
-28V
IC11 µA709C
IC12 LM301
IC13 MC1495
IC14 CA3030
Q32 MPS L08
Q33 MPS L08
Q34 L08
Q35 2N3963
Q36 2N3640
Q37 2N2905A HEATSINK
Q38 2N2219A HEATSINK
Q39 2N4037 HEATSINK
Q40 2N5160 HEATSINK
CR27 IN4581
CR28 IN4581
CA3030
µA795
µA709C (BOTTOM VIEW)
REF DESIG. NOT USED
R181 C76
R186
R188
WAVETEK SAN DIEGO CALIFORNIA
SCHEMATIC, MAIN BOARD
MODEL NO. 146
DWG NO. 3MT 3202
0103-00-0056
REV. G
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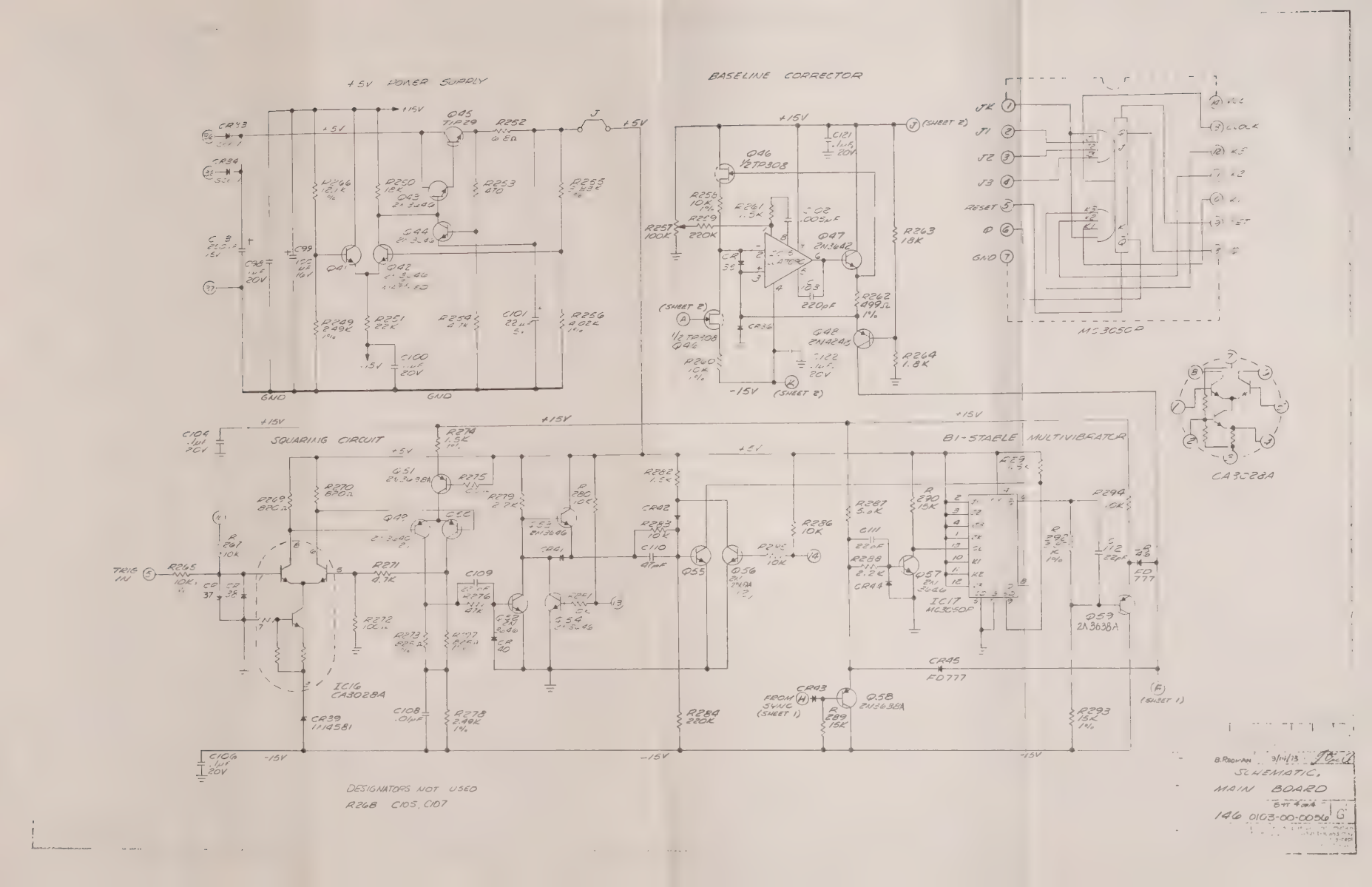
+5V POWER SUPPLY
BASELINE CORRECTOR
SQUARING CIRCUIT
BI-STABLE MULTIVIBRATOR
+15V
-15V
+5V
GND
MC3050P
CA3028A
DESIGNATORS NOT USED
R268 C105, C107
B. Rodman 3/14/73
SCHEMATIC,
MAIN BOARD
146 0103-00-0056 G

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REV	ECN	BY	CHK	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG, MAIN	0101-00-0056	WVTK	0101-00-0056	1
NONE	SCHEMATIC, MAIN	0103-00-0056	WVTK	0103-00-0056	1
A1	SINE MOD	182-011	WVTK	1200-00-0002	1
SW1	FNEW SW ASSY	180-006	WVTK	1202-00-0016	1
SW2	D/C OFFSET SW ASSY	180-008	WVTK	1202-00-0018	1
IC17	PATCH BLOCK	150-028	WVTK	1295-00-0089	1
NONE	SPACER	4040	WVTK	1800-00-0653	1
C89	CAP,CER,5PF,1KV	00-150	CKL	1500-00-5011	1
C81 C82	CAP,CER,10PF,1KV	00-100	CKL	1500-01-0011	2
C24 C47 C50	CAP,CERW,.001MF,1KV	00-102	MFC	1500-01-0211	3
C10A C11A C11B C11C C12B C23 C2A C33 C3A C35 C36 C53 C54 C61 C65 C67 C68 C77 C79 C8A C83 C84 C86 C90 C91 C95 C96	CAP,CER,.01MF,50V	CK-103	MFC	1500-01-0310	26
C94 C97	CAP,CERW,.1MF,50V	CK-104	CKL	1500-01-0410	2
C100 C109 C105 C106 C117 C118 C119 C120 C121 C122 C123 C124 C125 C126 C127 C128 C1B C19 C2V C55 C56	CAP,CERW,.1MF,20V	EPC-106	CKL	1500-01-0413	25

WAVETEK PARTS LIST | TITLE MAIN | ASSEMBLY NO 1100-00-0056 PAGE: 1 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C99	CAP,ELECT,100MF,10V	5000[illegible]	[illegible]	1500-11-0101	1
C113	CAP,ELECT,250MF,10V	5000[illegible]	[illegible]	1500-12-5101	1
C81	CAP,POLYC,.01MF,100V	[illegible]	[illegible]	1500-41-0510	1
C40	CAP,POLYC,.1MF,10OV	[illegible]	[illegible]	1500-[illegible]	1
C39	CAP,POLYC,1MF,100V	210-81F-105F	[illegible]	1500-41-0500	1
C10 C11 C37 C38	CAP,POLYC,5MF,100V	C1A505	[illegible]	1500-45-0500	4
C26 C31 C42 C45	VARI,7-35PF,250V	73-[illegible]-25 7/16 DI	[illegible]	1500-54-5000	4
C101 C73	CAP,TANT,22MF,15V	[illegible]	[illegible]	1505-72-A01	2
C7A C87 C92 C96	CAP,TANT,5.6MF,35V	150D565X9035A2	[illegible]	1505-75-A502	4
NONE	MAIN	186-155	[illegible]	1700-00-0056	1
NONE	SKT,IC,16PIN	10-A16	[illegible]	2100-05-0003	1
NONE	TERM	2000A1	[illegible]	2100-05-0004	1
NONE	TERM	2000A1	[illegible]	2100-05-0010	24
NONE	CONN	8659A-8	[illegible]	2100-05-0017	1
NONE	PLUGS	6119P2-2	[illegible]	2100-05-0020	24
NONE	HEAT SINK	WF-207	[illegible]	2400-11-0001	1
NONE	TRANSIPAD	10121	[illegible]	2800-11-0003	1

WAVETEK PARTS LIST | TITLE MAIN | ASSEMBLY NO 1100-00-0056 PAGE: 3 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R265	[illegible]	MF3206-103	[illegible]	[illegible]	1
R110 W111 W113 R124 R217 R221 W223 W272 R275 W55 W65 W94	[illegible]	[illegible]	[illegible]	[illegible]	14
R170 W19 W195 W196 W5A W7A W9	[illegible]	MRA55F-1001F	[illegible]	[illegible]	5
W189 W222 W258 W260 W267 W280 W281 W283 W285 W286 W294 W66 W95	[illegible]	MRA55F-1002F	[illegible]	[illegible]	10
R155 W156 W157 W158 W196 W223 W267 W28A	[illegible]	MRA55F-1004F	[illegible]	[illegible]	10
W117 W120 W121	[illegible]	MRA55F-1101F	[illegible]	[illegible]	3
W102 W106 W107	[illegible]	[illegible]	[illegible]	[illegible]	3
R200 W266	[illegible]	MRA55F-1212F	[illegible]	[illegible]	2
W185	[illegible]	[illegible]	[illegible]	[illegible]	1
W133	[illegible]	MRA55F-1500F	[illegible]	[illegible]	1
W10 W11 W14 W16 W178 W177 W182 W191 W207 R214 W215 W22 W251 W270 W282 W281 W3 W53 W59 W60 W66 W67	[illegible]	MRA55F-1501F	[illegible]	[illegible]	16

WAVETEK PARTS LIST | TITLE MAIN | ASSEMBLY NO 1100-00-0056 PAGE: 4 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C44 C65 C69 C9A					
C5A C7A	CAP,CER,150PF,1KV	CK-151	CKL	1500-01-4111	2
C109 C111 C112 C6B	CAP,CER,.22MF,1KV	CK-224	MFC	1500-02-2011	4
C103 C13 C19 C2 C2U C2V C2Z C2A C4 CA C7Z C8 C9	CAP,CER,.220PF,1KV	CK-221	MFC	1500-02-2111	12
C17	CAP,CERW,.0022,1KV	CK-222 LONG LEAD	CKL	1500-02-2201	1
C60 C78	CAP,CER,.33PF,1KV	CK-330	MFC	1500-03-3011	2
C110	CAP,CERW,.47MF,1KV	CK-474	MFC	1500-04-7111	1
C27 C62 C70	CAP,CER,.470PF,1KV	CK-471	MFC	1500-04-7111	3
C1 C102 C12 C1A C1B C21 C3 C5 C7 C71	CAP,CER,.056MF,50V	CK-563	MFC	1500-05-0210	13
C57 C9B	CAP,CER,.68PF,1KV	CK-680	MFC	1500-06-8001	2
C8A C89 C9A	CAP,MICA,150PF,500V	DM15-151J	BMFC	1500-11-5100	3
C52	CAP,MICA,20PF,500V	DM15-200J	BMFC	1500-12-0000	1
C30	CAP,MICA,30PF,500V	DM15-300J	BMFC	1500-13-0000	1
C4A	CAP,MICA,.0068,5%	DM15-682J	BMFC	1500-14-8000	1
C85	CAP,MICA,.0082,5%	DM15-822J	BMFC	1500-18-2101	1
C8B C91	CAP,MICA,.01PF,500V	DM15-910J	BMFC	1500-19-1000	2

WAVETEK PARTS LIST | TITLE MAIN | ASSEMBLY NO 1100-00-0056 PAGE: 2 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	TRANSIPAD	10126	[illegible]	2800-11-0004	1
NONE	HEATSINK NUT	11054	[illegible]	2800-11-0005	1
NONE	HEATSINK BODY	11053	[illegible]	2800-11-0006	1
NONE	FERRITE HEAD	56-590-65/3B	[illegible]	4100-00-0001	1
W181 W159	POT,TWIM,10K	91A1[illegible]	[illegible]	4400-01-0103	1
R5 R6 W7 W8	POT,TWIM,1K	91A1[illegible]	[illegible]	4400-01-0209	4
R15A W195 W201 W205	POT,TWIM,10K	91A1[illegible]	[illegible]	4400-01-0303	3
R1A W257 W58 W35 W75	POT,TWIM,100K	91A1[illegible]	[illegible]	4400-01-0402	5
W80	POT,TWIM,200	91A1[illegible]	[illegible]	4400-02-0101	1
W1A7 W109	POT,TWIM,2K	91A1[illegible]	[illegible]	4400-02-0201	2
W22A	POT,TWIM,20K	91A1[illegible]	[illegible]	4400-02-0301	1
R138 W135 W25 R231 W52 W48 W49	POT,TWIM,500	91A1[illegible]	[illegible]	4400-02-0106	5
R224 W233	WES,C,1/2W,5%,1K	RC20GF-102	STKPL	4700-06-0100	2
R252	WES,C,1/2W,5%,6.8	RC20GF-6R8	STKPL	4700-25-0685	1
R175 W178 W86 W87	WES,C,1/2W,5%,8.2	RC20GF-8R2	STKPL	4700-25-0829	4
R37	WES,C,1/2W,5%,1.8M	RC20GF-185	STKPL	4700-25-1859	1
R18 R85	WES,C,1/2W,10%,8.2M	RC20GF-825	STKPL	4700-26-8259	2

WAVETEK PARTS LIST | TITLE MAIN | ASSEMBLY NO 1100-00-0056 PAGE: 5 | REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R72					
R187 W209 W29 W55 R69 W78	WES,MF,1/8W,1%,15K	RN55D-1502F	[illegible]	4701-03-1502	6
R23A W201	WES,MF,1/8W,1%,15	[illegible]	[illegible]	4701-03-1500	2
R100 W108	WES,MF,1/8W,1%,1.82K	[illegible]	[illegible]	4701-03-1821	2
R206 W226 W254	WES,MF,1/8W,1%,1.78K	RN55D-1781F	[illegible]	4701-03-1781	3
W250 W263	RES,MF,1/8W,1%,19.2K	[illegible]	[illegible]	[illegible]	2
W138	WES,MF,1/8W,1%,200	[illegible]	[illegible]	4701-03-2000	1
R251	WES,MF,1/8W,1%,21.5K	RN55D-2152F	[illegible]	4701-03-2152	1
R105 W109 W15A W68 W69 W94	WES,MF,1/8W,1%,2.15K	RN55D-2151F	[illegible]	4701-03-2151	6
W108 W170 W18A R213 R278 W248	WES,MF,1/8W,1%,2.21K	[illegible]	[illegible]	4701-03-2211	5
W259 W28A W31	WES,MF,1/8W,1%,221K	RN55D-2213F	[illegible]	4701-03-2213	3
W121 W188 W193 R236	WES,MF,1/8W,1%,2.37K	RN55D-2371F	[illegible]	4701-03-2371	4
R11A W120 W122 W12A R210	WES,MF,1/8W,1%,240	[illegible]	[illegible]	4701-03-2400	5
R132 W131 W264 W27A W6A	WES,MF,1/8W,1%,2.49K	RN55D-2491F	[illegible]	4701-03-2491	4
W134	WES,MF,1/8W,1%,274	RN55D-2740F	[illegible]	4701-03-2740	1

WAVETEK PARTS LIST | TITLE MAIN | ASSEMBLY NO 1100-00-0056 PAGE: 6 | REV G

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES | DRAWN | DATE | MATERIAL | FINISH WAVETEK PROCESS | DO NOT SCALE DWG | SCALE | TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ± .010 ANGLES ± .5° .XXX ± .005

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: MAIN BOARD

MODEL NO 146 | DWG NO 1100-00-0056 | REV G | SIZE D | CAGE CODE 23338 | SHEET 1 OF 2

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REV	E.N.	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R208	RES,MF,1/8W,1%,3.01K	RN55D-3011F	TRW	4701-03-3011	1
R219	RES,MF,1/8W,1%,10.1K	RN55D-1012F	TRW	4701-03-1012	1
R100 R101 R171 R225 R252 R56 R57 R91 R92	RES,MF,1/8W,1%,31K	RN55D-3102F	TRW	4701-03-3102	9
R216	RES,MF,1/8W,1%,4.53K	RN55D-4531F	TRW	4701-03-4531	1
R157 R180 R187 R196 R197	RES,MF,1/8W,1%,33.2	RN55D-33R2F	TRW	4701-03-33R2	5
R87 R88	RES,MF,1/8W,1%,3.48K	RN55D-3481F	TRW	4701-03-3481	2
R255 R262 R42	RES,MF,1/8W,1%,4.53K	RN55D-1R51F	TRW	4701-03-1R51	3
R35	RES,MF,1/8W,1%,1.02K	RN55D-1021F	TRW	4701-03-1021	1
R103	RES,MF,1/8W,1%,2	RN55D-3R01F	TRW	4701-03-4020	1
R256	RES,MF,1/8W,1%,6.04K	RN55D-6021F	TRW	4701-03-6021	1
R125 R239	RES,MF,1/8W,1%,8.32K	RN55D-8321F	TRW	4701-03-8321	2
R151 R160 R199 R202 R201 R253	RES,MF,1/8W,1%,6MW	RN55D-6R00F	TRW	4701-03-4R00	6
R190	RES,MF,1/8W,1%,6.65K	RN55D-6651F	TRW	4701-03-6651	1
R180 R32 R6 R76	RES,MF,1.5W,1%,66.5	RN55D-66R5F	TRW	4701-03-8660	8
R139 R20 R258 R271 R80 R90	RES,MF,1/8W,1%,8.25K	RN55D-8251F	TRW	4701-03-8251	6

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R81	RES,MF,1/8W,1%,1M	RN60D-1004F	TRW	4701-14-1004	1
R182 R81	RES,MF,1/8W,1%,1,91K	RN60D-1911F	TRW	4701-14-1911	2
R150 R161 R197 R198	RES,MF,1/8W,1%,332	RN60D-4320F	TRW	4701-14-4320	4
R17 R39	RES,MF,1/8W,1%,464K	RN60D-4643F	TRW	4701-14-4643	2
R145 R148 R234 R235 R236 R242 R243 R244 R245 R246 R247 R249	RES,MF,1/8W,1%,49.9	RN60D-49R9F	TRW	4701-14-4999	12
R12 R13 R41 R61 R88 R89	RES,SET,2-1K,1/8% QTY(2)1870I-03-1091	182-401-89	AVX	0740-00-0089	5
	RES,MF,MIXED SET	182-401-50	AVX	0799-00-0044	1
R24 R25	RES,MF,1/8W,1%,1K PART OF 4789-00-0033 QTY(2)				
R26 R27	RES,MF,1/8W,1%,10K PART OF 4784-00-0033 QTY(2)				
R28 R29	RES,MF,1/8W,1%,100K PART OF 4784-00-0033 QTY(2)				
R30 R31	RES,MF,1/8W,1%,1M PART OF 4789-00-0033 QTY(2)				
CR2 CR27 CR29 CR34	DIODE,ZENER 6.2V	1N4734	MMC	3961-01-0923	6

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
Q28 Q6 Q67	TRANS	2N5209	MOT	4901-05-0420	3
Q11 Q26 Q30 Q64 Q66 Q52 Q55 Q58 Q63 Q8	TRANS	2N3638	MOT	4901-01-0480	10
Q34	TRANS	2N4067	MOT	4901-04-0670	1
Q4A	TRANS	2N4249	MOT	4901-04-2480	1
Q12 Q15 Q17 Q21 Q24 Q25 Q27 Q31 Q9	TRANS	2N5138	MOT	4901-05-1380	9
Q50	TRANS	2N4249	MOT	4901-04-1800	1
Q1 Q16	TRANS	2N5401	MOT	4901-05-0080	2
Q10 Q14 Q19 Q20 Q62 Q33 Q36	TRANS	MPS-L01	MOT	4902-00-0080	7
Q45	TRANS	TIS-26	TI	4902-00-0260	1
Q5 Q46	TRANS	TIS-61A	TI	4902-00-1080	2
Q22 Q23	TRANS,MATCHED PAIR	182-401-52	AVX	0494-00-0000	1
Q13 Q2	TRANS,SET,2N5401	182-401-54	AVX	4494-00-0000	2
Q6 Q7	TRANS,MATCHED PAIR	182-401-53	AVX	4494-00-0000	1
Q60 Q50	TRANS,MATCHED PAIR	182-401-10	AVX	4494-00-0015	1

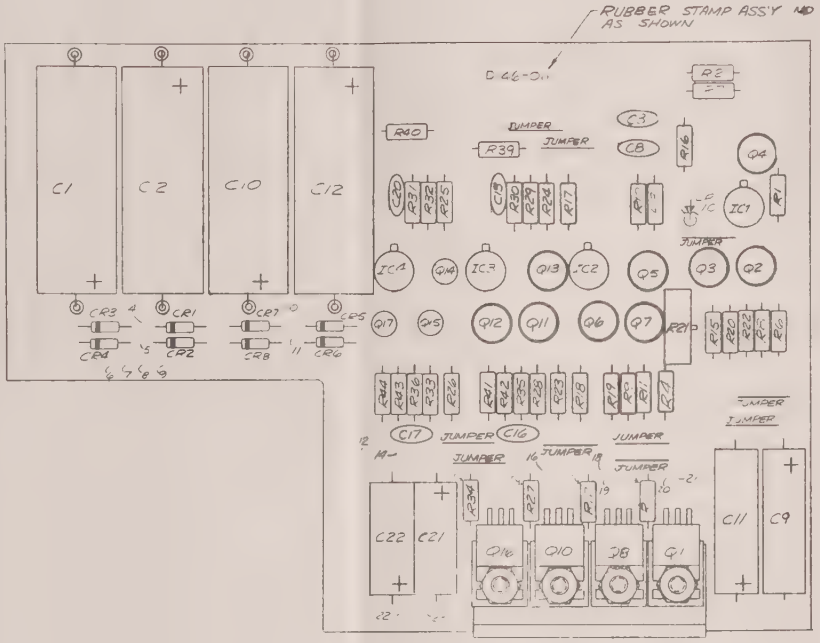
REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R276	RES,MF,1/8W,1%,47.5K	RN55D-4752F	TRW	4701-03-4752	1
R119 R180 R242	RES,MF,1/8,1%,499	RN55D-4990F	TRW	4701-03-4990	3
R211 R50 R52 R60 R69 R69	RES,MF,1/8W,1%,4.99K	RN55D-4991F	TRW	4701-03-4991	6
R118 R125 R138 R183	RES,MF,1/8W,1%,511	RN55D-5110F	TRW	4701-03-5110	4
R169 R150 R152	RES,MF,1/8W,1%,56.2K	RN55D-5622F	TRW	4701-03-5629	3
R247	RES,MF,1/8W,1%,5.76K	RN55D-5761F	TRW	4701-03-5761	1
R103 R107	RES,MF,1/8W,1%,6.19K	RN55D-6191F	TRW	4701-03-6191	2
R76	RES,MF,1/8W,1%,681	RN55D-6810F	TRW	4701-03-6810	1
R21A R220	RES,MF,1/8W,1%,6.98K	RN55D-6981F	TRW	4701-03-6981	2
R86	RES,MF,1/8W,1%,750	RN55D-7500F	TRW	4701-03-7500	1
R208 R98 R85	RES,MF,1/8W,1%,7.5K	RN55D-7501F	TRW	4701-03-7501	3
R3A	RES,MF,1/8W,1%,78.7K	RN55D-7872F	TRW	4701-03-7872	1
R102 R21 R269 R270 R273 R277	RES,MF,1/8W,1%,825	RN55D-8250F	TRW	4701-03-8250	6
R162 R180 R172 R173	RES,MF,1/8W,1%,8.25K	RN55D-8251F	TRW	4701-03-8251	4
R152 R75	RES,MF,1/8W,1%,82.5	RN55D-8252F	TRW	4701-03-8252	2
R115 R127	RES,MF,1/8W,1%,90.9	RN55D-9099F	TRW	4701-03-9099	2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
CR6 CR9					
CR33 CR36	DIODE	SCI-1	SENT	4801-02-0001	2
CR10 CR16	DIODE	1N4718	GI	4802-01-1718	2
CR21 CR22 CR23 CR24 CR45 CR46	DIODE	FD-777	FAIR	4807-02-0777	6
CR1 CR13 CR17 CR18 CR19 CR20 CR25 CR26 CR29 CR31 CR32 CR12 CR15 CR16 CR47 CR38 CR48 CR41 CR42 CR43 CR44 CR5 CR40 CR4 CR8 CR7 CR10	DIODE	FD-6666	FAIR	4807-02-6666	26
CR18 CR11 CR12 CR13	DIODE,SPEC,2-FD-777 QTY(4)2807-02-0777	182-401-57	AVX	4494-00-0002	1
CR27 CR48	DIODE,SPEC,2-FD-777 QTY(2)2807-02-0777	182-401-58	AVX	4494-00-0003	1
Q1A	TRANS	2N2219A	NSC	4901-02-2191	1
Q55 Q56	TRANS	2N2484	MOT	4901-02-4841	2
Q37	TRANS	2N2905A	NSC	4901-02-4051	1
Q10 Q35	TRANS	2N3643	FAIR	4901-03-5630	2
Q28 Q5 Q51 Q58 Q59 Q60	TRANS	2N3638A	CAMIR	4901-03-8341	6
Q1A	TRANS	2N3904	NSC	4901-02-3901	1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
		4TY2I2I6N01-03-0000			
Q41 Q42	TRANS,MATCHED PAIR 4TY2I2I6N01-03-0000	182-401-11	AVX	4494-00-0016	1
IC12	IC	LM 311N	NSC	7000-03-0100	1
IC13	IC	MC1496L	MOT	7000-18-4900	1
IC16	IC	CA-3094A	RCA	7000-14-2800	1
IC10	IC	CA-4002	RCA	7000-10-4000	1
IC14	IC,CLASS I,CA-4010 4TY2I2I7000-03-0000	180-401-19	AVX	7200-00-0001	1
IC1 IC11 IC15 IC2 IC5 IC4 IC5 IC6 IC7 IC8 IC9	IC,CLASS I,MA-709 4TY2I2I7000-07-0000	180-401-18	AVX	7200-00-0005	11

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: MAIN BOARD
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± XX ± .030		
	DO NOT SCALE DWG.		MODEL NO. 416 DRAWING 1100-00-0056 REV G
	SCALE		CODE IDENT 23338 SHEET 2 OF 2



NOTES UNLESS OTHERWISE SPECIFIED
1. NUMBER INDICATE WIRE TERMINATION POINTS.

tolerance unless otherwise specified	rev	ecn	by	date	app
XXX ± 010 XX ± 030	WAVETEK san diego, calif				
scale TWICE	by	date	app		
material N/A	title ASSEMBLY POWER SUPPLY				
finish N/A	model no 4'6	dwg no 010-00-0057	rev -		

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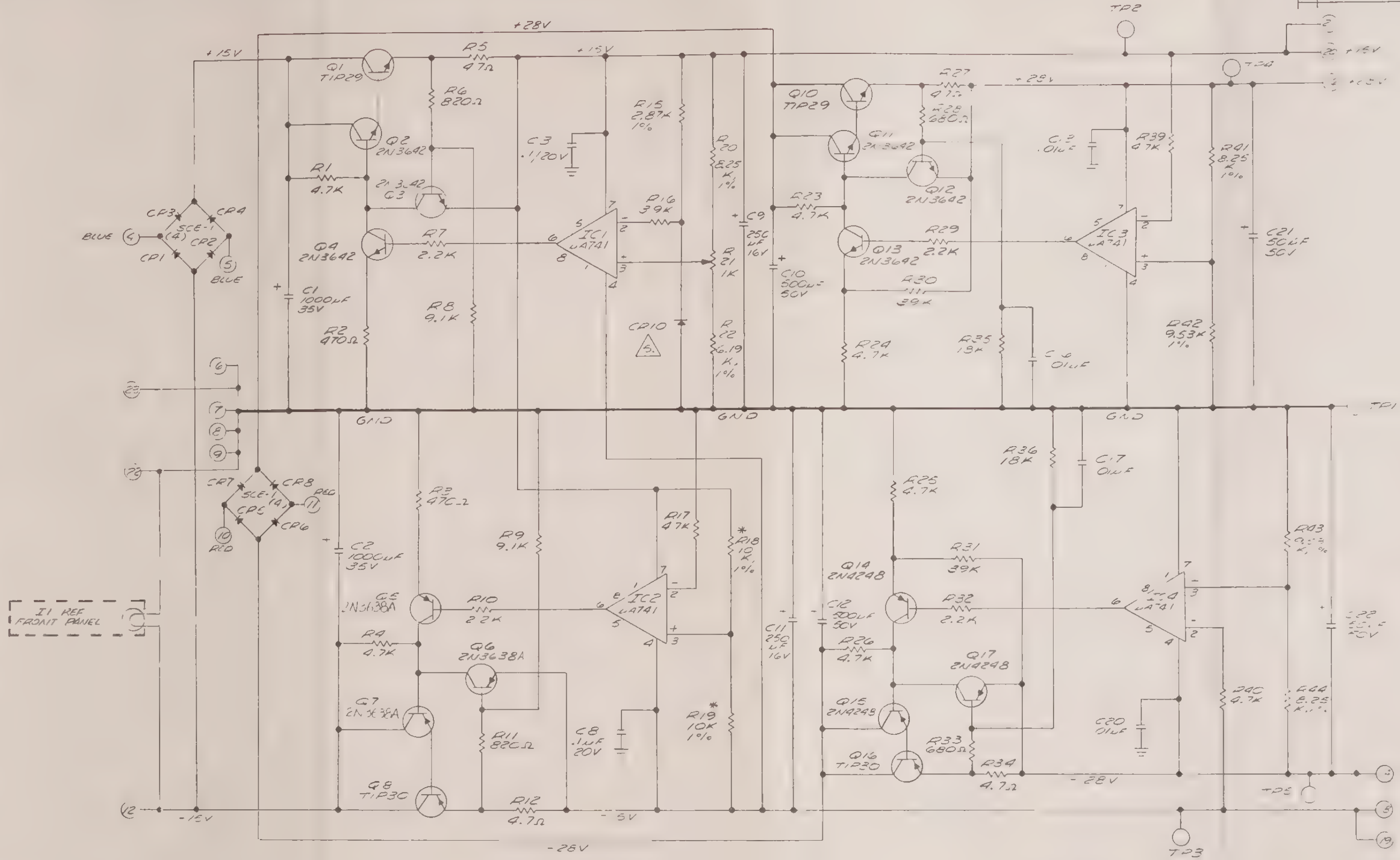

+28V
+15V
Q1
TIP29
R5
47Ω
R6
820Ω
Q2
2N3642
R1
4.7K
Q3
2N3642
Q4
2N3642
R7
2.2K
C1
1000µF
35V
R2
470Ω
R8
9.1K
C3
.1/20V
R15
2.87K
1%
R16
39K
IC1
µA741
R20
8.25 K, 1%
R21
1K
R22
6.19 K, 1%
CR10
5.
C9
250 µF
16V
C10
500µF
50V
Q10
TIP29
R27
R28
680Ω
Q11
2N3642
Q12
2N3642
R23
4.7K
Q13
2N3642
R29
2.2K
R30
39K
R24
4.7K
R35
18K
IC3
µA741
R39
4.7K
R41
8.25 K 1%
R42
9.53K
1%
C21
50µF
50V
TP2
TP1
+15V
BLUE
CR3
CR4
SCE-1
(4)
CR2
CR1
BLUE
GND
CR7
CR8
SCE-1
(4)
CR5
CR6
RED
RED
I1 REF
FRONT PANEL
-15V
C2
1000µF
35V
R3
470Ω
Q5
2N3638A
R4
4.7K
Q6
2N3638A
Q7
2N3638A
Q8
TIP30
R9
9.1K
R10
2.2K
R11
820Ω
R12
4.7Ω
-5V
-28V
IC2
µA741
R17
4.7K
*
R18
10 K, 1%
C8
.1µF
20V
*
R19
10K
1%
C11
250 µF
16V
C12
500µF
50V
R25
4.7K
R36
18K
Q14
2N4248
R31
39K
R32
2.2K
R26
4.7K
Q17
2N4248
Q15
2N4248
Q16
TIP30
R33
680Ω
R34
4.7Ω
-28V
IC4
µA741
C20
.01µF
R40
4.7K
R43
R44
8.25
TP5
TP3
-28V

Δ ZENER DIODES ARE SELECTED PER WAVETEK SPEC. 130-506 (CR10)

4. CIRCLED NUMBERS, I.E. (1) ETC ARE WIRING INTERCONNECTION POINTS

3. DIODES ARE FD6666

2. RESISTORS ARE CARBON, 1/2W, 10%

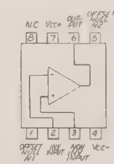
1. * INDICATES MATCHED PAIR (R18 & R19)

NOTES: UNLESS OTHERWISE SPECIFIED

REF. DES. NOT USED
C4, C5, C6, C7, C14, C15, C18, C19
R13, R14, R37, R38
CR9, CR11, CR12 CR13

LAST REF DESIG

R44 IC4
C22 Q17
CR13



741

REV	ECN	BY	DATE	APP
D	ECN			
C	ECN 552			
B	ECN 1335			
A	ECN 795			

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0 30

WAVETEK SAN DIEGO CALIFORNIA

SCALE
BY
DATE 2-5-72
APP

MATERIAL N/A

TITLE SCHEMATIC, POWER SUPPLY

MODEL NO 146
DWG NO 0103-00-0057
REV E

FINISH N/A

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REFERENCE DESIGNATIONS	PART DESCRIPTION	MFG-PART-NUMBER	QTY
NONE	ASSY MANG,PC,NEW	0101-0001-07	1
NONE	SCHEMATIC,POWER	0101-0001-SC2	1
NONE	MKR		1
NONE	INSULATOR,WIRE	1.2-111	1
C15 C16 C17 C20	CAP,CER,.01UF,50V	CK-105	4
C4 C5	CAP,CER,.1UF,50V	CK20-104	2
C1 C2	CAP,ELECT,1000UF,35V	19113A6035GL8	2
C11 C9	CAP,ELECT,2500UF,16V	5000D257G016DF7	2
C21 C22	CAP,ELECT,500UF,50V	5000H50G050DD7	2
C10 C12	CAP,ELECT,5000UF,50V	19113A5050GL4	2
NONE	PIN,PC	160-111	1
NONE	TWNSKIP80	1101256	1
W21	PWR,TWIN,1K	0140W1K	1
W12 W27 W30 W5	WIRE,#22,SOLID,7		4
W34 W36	WIRE,MF,1/4W,1%,1M,2R	MMA6EL-1M22F	2
W17 W29 W32 W7	WIRE,MF,1/4W,1%,2.21K	MMA6EL-2A21F	4
W33	WIRE,MF,1/4W,1%,2.49K	MMA6EL-2A49F	1
W31 W41	WIRE,MF,1/4W,1%,5.62K	MMA6EL-5A62F	2

REFERENCE DESIGNATIONS	PART DESCRIPTION	MFG-PART-NUMBER	QTY
Q16 IM	[illegible]	[illegible]	[illegible]
IC1 IC2 IC5 IC6	[illegible]	[illegible]	[illegible]

REFERENCE DESIGNATIONS	PART DESCRIPTION	MFG-PART-NUMBER	QTY	WAVETEK NO.	QTY/ASY
W16	WIRE,MF,1/4W,1%,3.92K	MMA6EL-3A92F	1	0701-03-3921	1
W2 W3	WIRE,MF,1/4W,1%,866	MMA6EL-8660F	2	0701-01-8660	2
W1 W17 W25 W28 W25 W26 W39 W4 W40	WIRE,MF,1/4W,1%,4.75K	MMA6EL-4751F	11	0701-03-4751	11
W22	WIRE,MF,1/4W,1%,8.19K	MMA6EL-8191F	1	0701-01-8191	1
W24 W35	WIRE,MF,1/4W,1%,887	MMA6EL-8870F	2	0701-01-8870	2
W11 W6	WIRE,MF,1/4W,1%,825	MMA6EL-8250F	2	0701-01-8250	2
W20 W31 W38	WIRE,MF,1/4W,1%,8.25K	MMA6EL-8251F	3	0701-03-8251	3
W8 W9	WIRE,MF,1/4W,1%,9.09K	MMA6EL-9091F	2	0701-03-9091	2
W42 W43	WIRE,MF,1/4W,1%,9.53K	MMA6EL-9531F	2	0701-03-9531	2
W18 W19	WIRE,BLT,2-19X,1/4W GET:210701-03-1002	1824501-00	2	0799-00-0018	2
CR10	DIODE	1N4941	1	[illegible]	1
CR1 CR2 CR3 CR4 CR5 CR6 CR7 CR8	DIODE	SCE-1	8	0801-02-0001	8
Q5 Q6 Q7	TRANS	2N4403	3	0801-01-4381	3
Q11 Q12 Q13 Q2 Q3 Q4	TRANS	2N3502	6	0801-01-4020	6
Q18 Q15 Q17	TRANS	2N6284	3	0801-06-2680	3
Q1 Q10	TRANS	TIP29	2	0802-00-0290	2

NOTE UNLESS OTHERWISE SPECIFIED

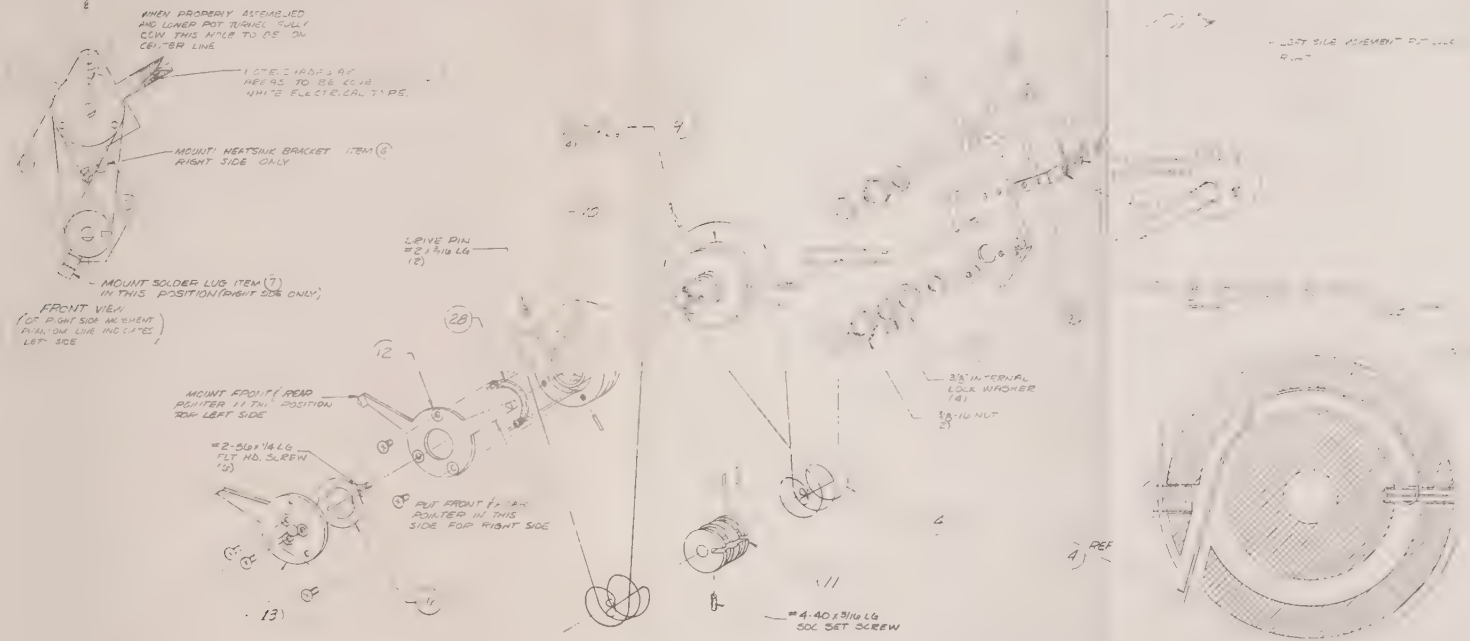
REMOVE ALL BURR, ANY BREAK SHARP EDGES | DRAWN | DATE | WAVETEK SAN DIEGO, CALIFORNIA

MATERIAL | CHECKED | TITLE: POWER SUPPLY

FINISH WAVETEK PROCESS | RELEASE APPROV | TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ± .010 ANGLES ± 1 .XXX ± .005 | DO NOT SCALE DWG | SCALE

MODEL NO 146 | DWG NO 1160-00-0057 | REV H

CUSTOMER AGENCY 23330 | SHEET [illegible]


WHEN PROPERLY ASSEMBLED AND LOWER POT TURNED FULL CCW THIS ANGLE TO BE ON CENTER LINE
NOTE: CHARGE LEAD HERE TO BE LOCATED WHITE ELECTRICAL TAPE.
MOUNT HEATSINK BRACKET ITEM (6) RIGHT SIDE ONLY
MOUNT SOLDER LUG ITEM (7) IN THIS POSITION (RIGHT SIDE ONLY)
FRONT VIEW (OF RIGHT SIDE MOVEMENT SHOWN LIKE INDICATES LEFT SIDE)
LIPIVE PIN #2 3/16 LG (2)
MOUNT FRONT (REAR) POINTER 11 THIS POSITION FOR LEFT SIDE
#2-56 x 1/4 LG FLT HD. SCREW (2)
PUT FRONT (REAR) POINTER IN THIS SIDE FOR RIGHT SIDE
3/8" INTERNAL LOCK WASHER (4)
1/8-10 NUT (2)
#4-40 x 3/16 LG SOC SET SCREW
ITEM 9, REAR VIEW
EXPLODED VIEW OF LOWER PULLEY TO SHOW WRAPPING OF DRIVE STRING ITEM (14) AROUND PIN
(4) REF
(11) REF

REV	ECN	BY	DATE	APP
B	ECN 745	BA	6/74	
A	ECN 362	BL	1/1/73	

TOLERANCE UNLESS OTHERWISE SPEC
.XX ± .010
.XXX ± .030
ANGLES ± 0°30'

WAVETEK SAN DIEGO CALIFORNIA

SCALE

MATERIAL

FINISH

TITLE
ASSEMBLY MOVEMENT

MODEL NO. 323 DWG. NO. [illegible] REV. D

REV	ECN	DATE
D	ECN 1164	2/6/74
C	ECN [illegible]	[illegible]

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.
	ASSY UNWD, LEFT MOVE	0102-06-00329	AVIA	0102-00-00329
	PULLEY,IDLER	140-319	AVIA	140U-00-2520
				140U-00-2933
				140U-00-2824
				140U-00-2819
		140-358	AVIA	140U-00-2864
		140-354	AVIA	1400-00-2834
	WASHER,SPRING MSP132W-07-0001	140-356	AVIA	140U-00-2844
	DRIVE BAND	140-339	AVIA	1400-00-9450
	PULLEY LUG	1497	SMITH	2100-04-0012
	INSERT # 4	74-11-1UN-13	PULCU	2800-04-00016
	WASHER,SHOULDER	2000	SMITH	2000-08-0001
	SPRING	E1-0100-9	LEE	2000-31-0001
	PUT,UIAL,SA	140-341	AVIA	0866-05-0003
	PUT,UIAL,SA	140-502	AVIA	0800-04-0008

WAVETEK PARTS LIST

TITLE: [illegible]

ASSEMBLY NO 1101-00-0070

REV: E

PAGE: 1

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	ENGINEER		TITLE: LEFT MOVEMENT
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX = .010 ANGLES = ± .25°		
	DO NOT SCALE DWG		MODEL NO 146 DWG NO 140-002 1101-00-0070 REV E
	SCALE		CAGE CODE 23338 SHEET 1 OF 1

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REFERENCE DESIGNATORS	PART DESCRIPTION	DWG-REQUIREMENT-NO	MFGR	WAVETEK NO.	QTY
NONE	ASSY UNDER LEFT MOVE	0102-00-0329	WVTK	0102-00-0329	1
11	PULLEY,IDLER	146-315	WVTK	1400-00-2570	1
8	PLATE,BEARING	146-317	WVTK	1400-00-2533	1
6	SHAFT,HEATSINK	146-330	WVTK	1400-00-2503	1
7	LUG,SOLDER USE 2100-00-0012	146-305	WVTK	1400-00-2579	1
15	POINTER,FRONT FROM:1400-00-2590	146-335	WVTK	1400-00-2609	1
12	POINTER,REAR FROM:1400-00-2590	146-330	WVTK	1400-00-2619	1
10	PULLEY,PI	146-355	WVTK	1400-00-2620	1
9	PULLEY,REAR	146-350	WVTK	1400-00-2630	1
16	WASHER,SPRING REF:3200-07-0001	146-350	WVTK	1400-00-2649	1
14	DRIVE STRING	146-335	WVTK	1400-00-2650	1
21	SOLDER LUG	14W7	SMITH	2100-00-0012	3
NONE	INSERT # 4	74-11-104-13	SUTCO	2800-09-0016	1
22	WASHER,SHOULDER	2000	SMITH	2800-20-0001	8
20	SPRING	21-0108-0	LEE	2800-31-0001	4
1	POT,DIAL,5K	146-561	WVTK	4000-05-0003	1

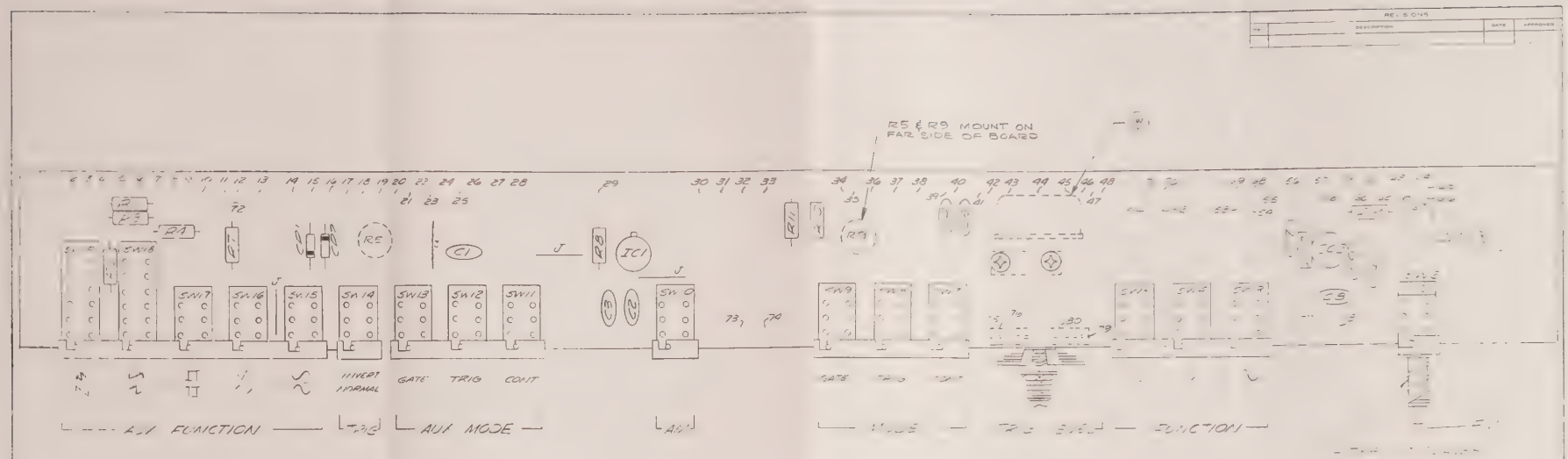
WAVETEK PARTS LIST	TITLE: RIGHT MOVEMENT	ASSEMBLY NO: 1101-00-0091	REV: F
		PAGE: 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	DWG-REQUIREMENT-NO	MFGR	WAVETEK NO.	QTY/PT
2	POT,DIAL,5K	146-562	WVTK	4000-05-0004	1

WAVETEK PARTS LIST	TITLE: RIGHT MOVEMENT	ASSEMBLY NO: 1101-00-0091	REV: F
		PAGE: 2	

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	ENGINEER		TITLE: RIGHT MOVEMENT
FINISH: WAVETEK PINK ESS	TOLERANCE UNLESS OTHERWISE SPECIFIED: .XXX .010 ANGLES ± .5°		
	DO NOT SCALE DRAWING		MODEL NO: 146
			DWG NO: 146-099 / 1101-00-0091 REV: F
			TECH CENT: 23338 SHEET 1 OF 1



1. SHOULDERS ON PUSH SWITCHES SHOULD BE TRIMMED BEFORE MOUNTING TO FRONT PANEL

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED

REV	ECN	BY	DATE	APP
	ECN 1764			
	ECN 1524			
		AL		
	ECN 949	BA		
A	ECN 873			

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30'

WAVETEK SAN DIEGO CALIFORNIA

SCALE 2/1

MATERIAL N/A

FINISH

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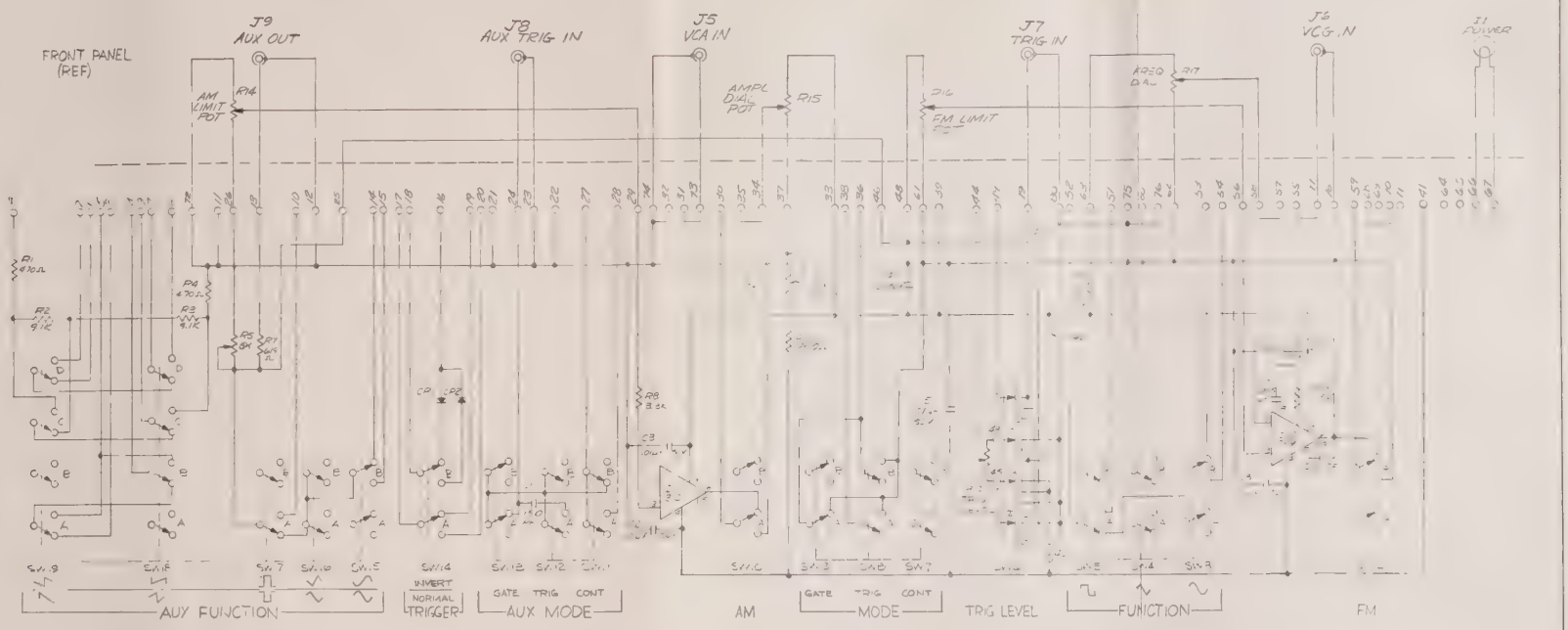

1. NUMBERS ARE FOR INTERCONNECTION PURPOSES ONLY, SEE 0004-00-0037

NOTES: UNLESS OTHERWISE SPECIFIED

REV	DESCRIPTION	DATE	APPROVED
A	ECO 870		

WAVETEK SAN DIEGO CALIFORNIA

SCALE: 1/1

DRAWN BY

DATE 2-13-73

APP

N/A

TITLE: SCHEMATIC SWITCH BOARD

MODEL NO. 146

DWG NO. 0003-00-0053

REV. D

FINISH N/A

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NOTE UNLESS OTHERWISE SPECIFIED

REV	ECN			

REFERENCE DESIGNATIONS	PART DESCRIPTION	MANUFACTURER PART NO.	SRCE	WAVETEK NO.	QTY/ASSY
A1A4	ASSY SWDG SWITCH	0181-0636	MFR	0181-0636	1
A1A5	SCHEMATIC SWITCH	0183-0636	MFR	0183-0636	1
DA6	THIN DF ASSY	146-003			
C3 C4 C5 C6 C8	CAP,CER,0.01UF,50V	CK-103	CML	1500-01-0103	
C3	CAP,CER,150PF,5%	CC-151	CML	1500-01-0111	1
C4	CAP,CER,220PF,5%	CC-221	CML	1500-01-0111	1
C7	CAP,CER,0.033UF,5%	CK-563	CML	1500-03-0103	1
A1A1A1	SWITCH	SWB-132	MFR	1700-0C-0000	1
J1	LEAD	CM7-7070	CMMFG	2400-00-0013	1
S3	PUSHBUTTON SWITCH	P-2136E	MFGDF	2500-00-0025	2
S3 A1A	PUSHBUTTON	P-1AP3F	MFGR	0006-03-0003	2
A1	MISCELLANEOUS	M-3936-1000F	IMA	A701-03-1000	1
P11	MISCELLANEOUS				
J3	MISCELLANEOUS	M-3936-1301F	IMA	A701-03-1301	1
	MISCELLANEOUS	M-3936-3301F	IMA	A701-03-3301	1
A1	MISCELLANEOUS	M-3936-4104F	IMA	A701-03-4104	1

WAVETEK PARTS LIST

TITLE	ASSEMBLY NO	REV
SWITCH	1300-06-0036	

SHIT AND SHIT	SWITCH ASSY PC	152-0001	MFR	5103-0-0003	3
NONE	SWITCH ASSY PC	1-00-0011	MFR	5103-00-0000	1
NONE	BUTTON	3-3623W5-BLACK	CML	5103-00-0013	1
SW1	IC	7400-03-1000	MFGR	7400-03-1000	1
A1C2	CAPACITOR 1UF+75% -10% 50V	13-501-13	MFR	7000-00-0005	1

WAVETEK PARTS LIST

TITLE	ASSEMBLY NO	REV
SWITCH	1300-06-0036 PANEL A	

REMOVE ALL BURRS AND BREAK SHARP EDGES

FINISH WAVETEK PROCESS

RELEASE APPROV

TOLERANCE UNLESS OTHERWISE SPECIFIED XXX .010 ANGLES 1 XX .020

DO Nnot SCALE DWG

WAVETEK

SWITCH

MODEL NO 46

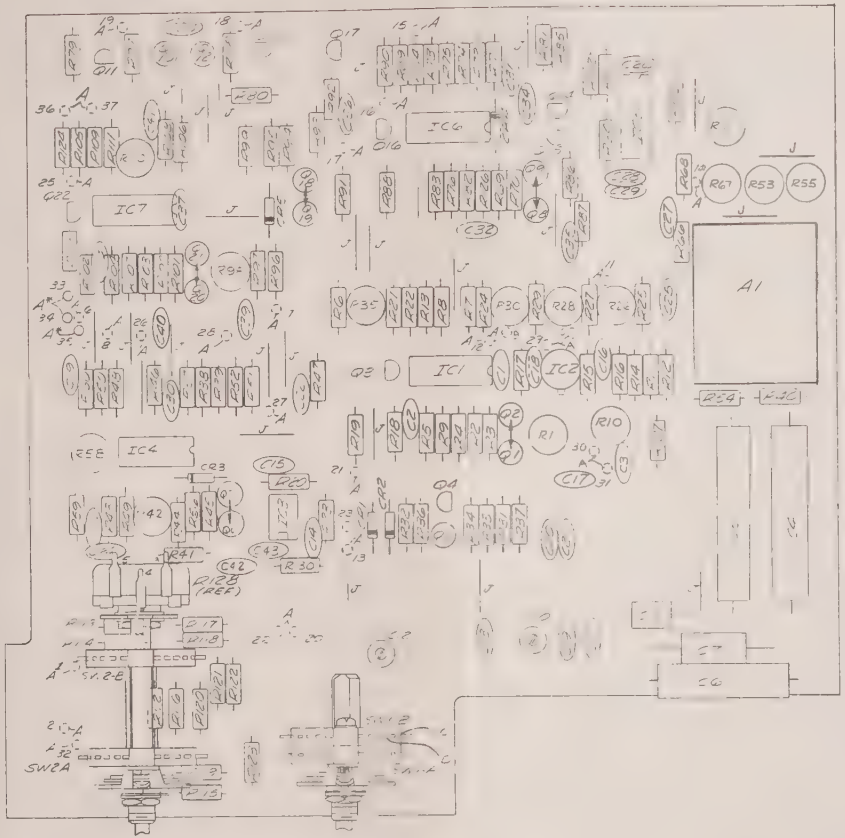
DWG NO 146-032 1300-06-0036

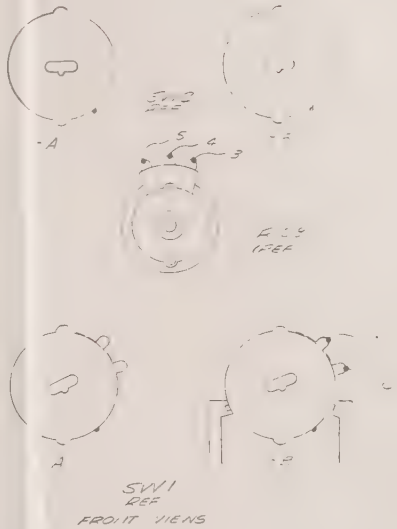
REV -

CODE IDENT 23338

SHEET 1 OF

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ECN 876		
B	ECN 945		
C	ODC ECN		





TOLERANCE UNLESS OTHERWISE SPEC	REV	ECN	BY	DATE	APP
.XX ± .02 .XXX ± .010 ANGLES ± 0°30	WAVETEK SAN DIEGO CALIFORNIA				
SCALE —	BY B. REDMAN	DATE 3/14/13	APP		
MATERIAL -	TITLE ASSY AUXILIARY BOARD				
FINISH -	MODEL NO 146	DWG NO 0101-00-0059	SHEET 1 OF 1	REV C	

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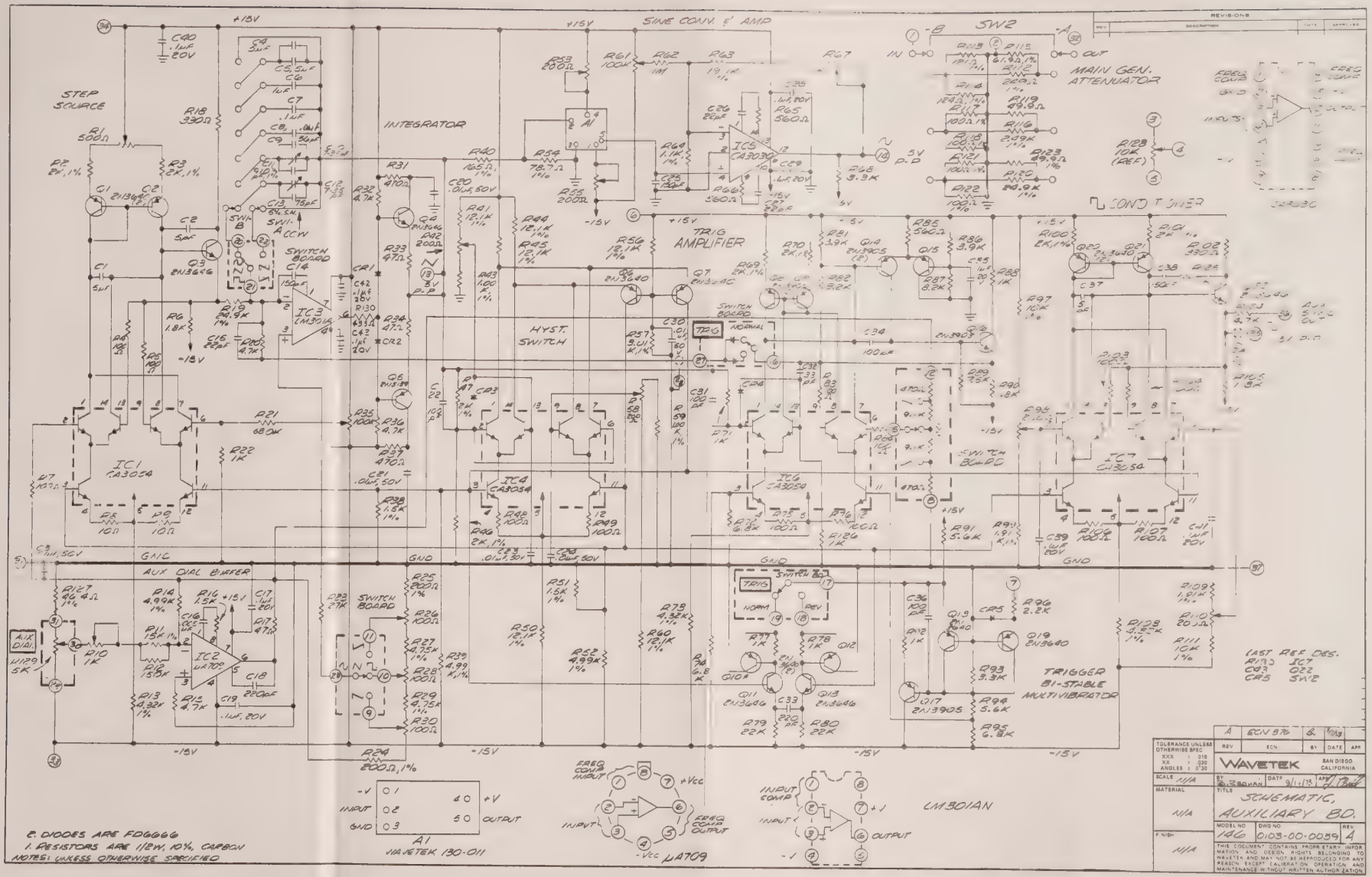
1 A* INDICATES ANIP PINS MOUNTED ON COMPONENT SIDE
NOTES: UNLESS OTHERWISE SPECIFIED:



REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

A	ECN 876	G.	3/1/73		
REV	ECN	BY	DATE	APP	

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 0°30

WAVETEK SAN DIEGO CALIFORNIA

SCALE N/A
BY G. BOMAN DATE 9/1/72 APP'D

MATERIAL N/A

FINISH N/A

TITLE SCHEMATIC, AUXILIARY 80.

MODEL NO 140 DWG NO 0103-00-0059 REV A

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REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NUMBER	MFGR	WAVETEK NO.	QTY
NONE	ASSY DWG, AUXILLARY	0101-00-0059	WK	0101-00-0059	1
NONE	SCHEMATIC, AUXILLARY	0103-00-0059	WK	0103-00-0059	1
W1	WIRE HOOK	130-0011	WK	1200-00-0001	1
XU1	ATTEN 3A ASSY	140-0017	WK	1202-00-0017	1
XU2	FREQ/PEAK00 3A ASSY	140-0004	WK	1202-00-0019	1
C1 C2 C37	CAP,CER,5PF,1KV	00-0036	CM	1500-00-5011	3
C22 C31 C36 C38	CAP,CER,.01MF,50V	00-0101	CM	1500-01-0111	4
C20 C21 C25 C26 C33 C34	CAP,CER,.01MF,3KV	00-0104	CM	1500-01-0311	6
C17 C19 C20 C24 C32 C34 C40 C41 C42 C43	CAP,CER,.1MF,25V	00-0104	CM	1500-01-0415	12
C45 C35	CAP,CER,.005MF,1KV	00-0151	CM	1500-01-5111	2
C46 C47	CAP,CER,.02MF,50V	00-0201	CM	1500-02-0111	2
C33	CAP,CER,.033MF,1KV	00-0331	CM	1500-02-0211	1
	CAP,CER,.33PF,1KV	00-330	CM	1500-03-1011	1
	CAP,CER,5PF,5KV	00-500	CM	1500-03-0501	1
	CAP,MICA,50PF,3KV	00-1500	CM	1500-13-0000	1
	CAP,MICA,750PF,500V	00-1575	CM	1500-17-5000	1
	CAP,MICA,1100PF,500V	00-1611	CM	1500-17-6100	1

WAVETEK PARTS LIST

TITLE: AUXILLARY

ASSEMBLY NO: 1100-00-0059

PAGE: 1

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NUMBER	MFGR	WAVETEK NO.
R71 R77 R78 R85 R96				
R111 R97	RES,MF,1/8W,1%			4701-03-1002
R8 R9				4701-03-1003
R84	RES,MF,1/8W,1%			4701-03-1101
R113	RES,MF,1/8W,1%			4711-03-1213
R81 R82 R83 R94 R95 R96	RES,MF,1/8W,1%			4711-03-1413
R114	RES,MF,1/8W,1%			4711-03-1503
R16 R38 R51	RES,MF,1/8W,1%			4701-03-1601
R11	RES,MF,1/8W,1%			4701-03-1502
R12	RES,MF,1/8W,1%			4701-03-1503
R43	RES,MF,1/8W,1%			4711-03-1603
R105 R8 R94	RES,MF,1/8W,1%			4701-03-1701
R83	RES,MF,1/8W,1%			4711-03-1712
R24 R25	RES,MF,1/8W,1%			4711-03-2202
R100 R101 R2 R3 R48 R49 R50 R70	RES,MF,1/8W,1%			4701-03-2201
R74 R80	RES,MF,1/8W,1%			4701-03-2152
R75 R80	RES,MF,1/8W,1%			4711-03-2211

WAVETEK PARTS LIST

TITLE: AUXILLARY

ASSEMBLY NO: 1100-00-0059

PAGE: 3

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NUMBER	MFGR	WAVETEK NO.

WAVETEK PARTS LIST

TITLE: AUXILLARY

ASSEMBLY NO:

PAGE: 5

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NUMBER	MFGR	WAVETEK NO.	QTY
L6	CAP,MULTL,.01MF,1KV	MA201031	CM	1500-01-0311	1
L7	CAP,MULTL,.1MF,100V	MA201104	CM	1500-01-0400	1
L8	CAP,MULTL,1MF,100V	2104081-1050	CM	1500-01-0500	1
L9 L5	CAP,MULTL,5MF,16V	C1A5003	CM	1500-03-0500	2
C10 L1C	VAR,1.7-55PF,250V	73-1M1R0002 7/32 MF	CM	1500-03-5000	1
XU1	BUS	140-0133	MM	1700-00-0054	1
XU2	CONN	[illegible]	MM	2100-03-0017	1
XU3	PIN,MALE	[illegible]	MM	2100-03-0020	1
R20 R20 R30	POT,1K,1W,10%	91AW1K0	MM	4603-01-0103	3
R10 R47	POT,1K,1W,1%	91AW1K	MM	4603-01-0102	2
R34 R61	POT,1K,1W,100%	91AW1U0A	MM	4603-01-0402	2
R111 R42 R53 R55 R58 R60	POT,1K,1W,200	91AW200	MM	4603-02-0101	6
R1	POT,1K,1W,500	91AW500	MM	4603-03-0104	1
R103 R104 R106 R107 R117 R118 R121 R122 R4 R42 R49 R5 R7 R75 R76 R83 R84	RES,MF,1/8W,1%		MM	4701-03-2001	13
R123 R126 R22 R43 R54	RES,MF,1/8W,1%	MM550-10018	MM	4701-03-1001	5

WAVETEK PARTS LIST

TITLE: AUXILLARY

ASSEMBLY NO: 1100-00-0059

PAGE: 2

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NUMBER	MFGR	WAVETEK NO.
R116	RES,MF,1/8W,1%	MM550-20490		
R115	RES,MF,1/8W,1%			4701-03-2493
R14 R34 R36	RES,MF,1/8W,1%			4701-03-2494
R63 R68 R85				
R41 R44	RES,MF,1/8W,1%	MM550-47681		
R113	RES,MF,1/8W,1%			4701-03-4781
R72 R76 R45	RES,MF,1/8W,1%			4711-03-4991

WAVETEK PARTS LIST

TITLE: AUXILLARY

ASSEMBLY NO: 1100-00-0059

PAGE: 4

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG. PART NUMBER	MFGR	WAVETEK NO.

WAVETEK PARTS LIST

TITLE: AUXILLARY

ASSEMBLY NO: 1100-00-0059

PAGE: 6

NOTE UNLESS OTHERWISE SPECIFIED

MATERIAL: AS NOTED ON DWG

FINISH: WAVETEK PROCESS

TOLERANCE UNLESS OTHERWISE SPECIFIED: FRACTIONS ±1/64, ANGLES ±1°, XX ±.010

DO NOT SCALE DRAWING

WAVETEK

AUXILLARY

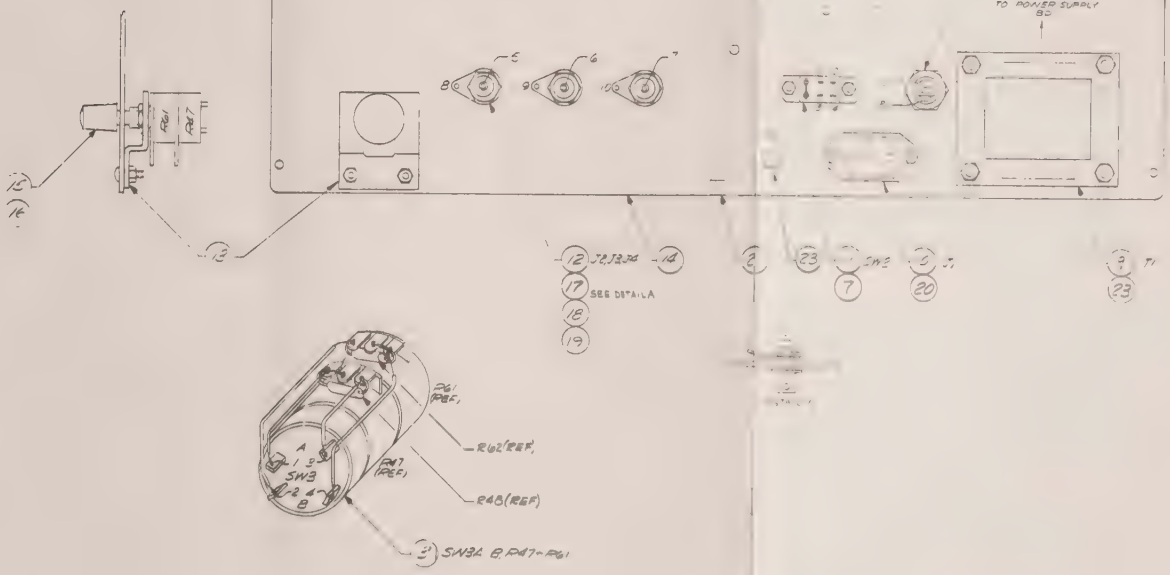
DRAWING NO. 146

DWG NO 146 033

1100-00-0059

CODE IDENT 23338

SHEET 1 OF 1



REV	DESCRIPTION	BY	DATE	APP'D
C	ECN 17964	EJ	3/2/98	
B	ECN 17418	EJ	5/5/97	

UNLESS OTHERWISE SPECIFIED: XXX ± .010, XX ± .030, ANGLES ± 0.30°

WAVETEK SAN DIEGO, CALIFORNIA

SCALE N/A | DWN B Cash | DATE 7/24/96 | QTY 2 Asstd

MATERIAL N/A

FINISH N/A

TITLE: ASSY REAR PANEL

MODEL NO | DWG NO SHEET 1 OF 1: 0102-00-01553 | REV G

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PC
	ASSY DRWG REAR PNL	0102-000-0330	AVTK	1102-00-0330	1
	TRANSFORMER	140-500	AVTK	1200-00-0026	1
35	BRKT,SB	140-320	AVTK	1400-00-0303	1
NONE	END BELL	157-500-E0	AVTK	1420-00-3220	1
14	PANEL,REAR	1400-00-0710	AVTK	1400-00-0716	1
NONE	[illegible]	1400-00-0476	AVTK	1400-00-0470	1
12	BRG [illegible]	RC-7900	KING	2100-01-0002	3
16	RELEPT/PUSH	EAC-361	SWLFT	2100-03-0005	1
20	TERM,LUG LUG	1414-4	SWITH	2100-04-0008	1
23	TERM,LUG LUG	1414-8	SWITH	2100-04-0016	1
18	SOLDER LUG	1447	SWITH	2100-04-0018	3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	KNOB	020-552	ELMA	2400-01-0003	1
19	KNOB CAP	040-302	ELMA	2400-11-0004	1
6	FUSE,2SEC,1/2A,3AB	313.500	LITFU	2400-03-0010	1
5	FUSE HOLD	345001	LITFU	2400-03-0012	1
21	PAST,CHASSIS	1341-C11	CASCU	2800-04-0002	2
17	WASHER,SHOULDER	2868	SWITH	2800-07-0004	3

WAVETEK PARTS LIST

TITLE	ASSEMBLY NO	REV
REAR PANEL ASSY	1101-00-0071	B
	PAGE: 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	OMIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PC
10	NYLON FLAT WASHER	2204-N-385	AMICN	2800-28-0003	3
5	FUT,SWITCH MOU [illegible]	4009-00-0060	AVTK	4009-00-0000	1
11	SWITCH ASSY SLIDE	4025B-LP	SWLFT	5105-00-0002	1
7	SOLDER GUARD	4025B-LP-SG	SWLFT	5105-04-0001	1

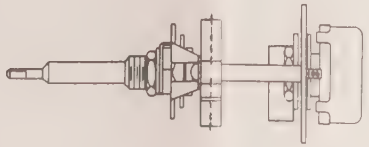
WAVETEK PARTS LIST

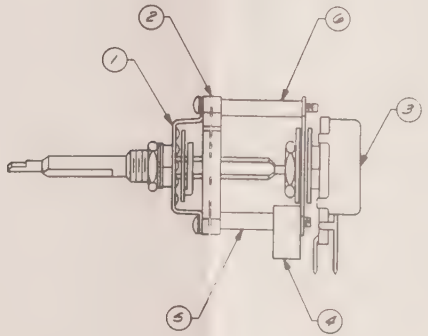
TITLE	ASSEMBLY NO	REV
REAR PANEL ASSY	1101-00-0071	B
	PAGE: 2	

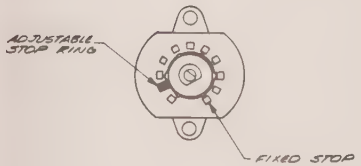
NOTE UNLESS OTHERWISE SPECIFIED

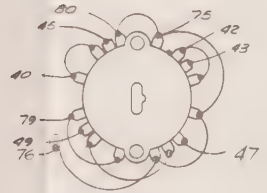
REMOVE ALL BURRS AND SHARP EDGES	DRAWN	DATE	WAVETEK
MATERIAL	ENGINEER		REAR PANEL ASSY
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XX ± .010 ANGLES XX ± .005		DWG NO 146-014
	DO NOT SCALE DWG		1101-00-0071 B
			SIZE C / SCALE 2/1 / SHEET 01

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED









NOTES:

1. SWITCH VIEWED FROM KNOB END OF BOARD
2. SWITCH SHOWN IN FULL CCW POSITION

REV	DESCRIPTION	BY	DATE	APP
C	1957	BR	5-11-79	
B	995	BA	1-20-79	
A	ECN 462	BA	9/6/78	

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .030
ANGLES ± 1°30'

WAVETEK SAN DIEGO, CALIFORNIA

SCALE –

DRAWN BY GRAY DATE 9-26-78 APP

MATERIAL –

TITLE SWITCH ASSY TRIGGER 2 of 2

MODEL NO. 146

DWG NO. 1202-00-0015

REV A

FINISH –

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATIONS	PART DESCRIPTION	CHTS-MFG-PART-NO	MFGR	WAVETEK NO.	QTY
4	BLOCK,S IMPORT	[illegible]	MVIK	140-000-1203	1
5	SPACER	[illegible]	MVIK	1400-00-4125	1
6	SPACER,4/40"	1400-00-0815	MVIK	1400-00-0815	1
9	PNT,CONT,10A ENUM=4000-01-0307	4609-71-0515	MVIK	4609-71-0515	1
7	WAFER	T-10A	CTS	5104-02-0005	1
8	DETENT,MOD ENUM=5104-01-0003	5104-99-0002	MVIK	5104-99-0002	1

WAVETEK PARTS LIST

TITLE
1416 SA ASSY

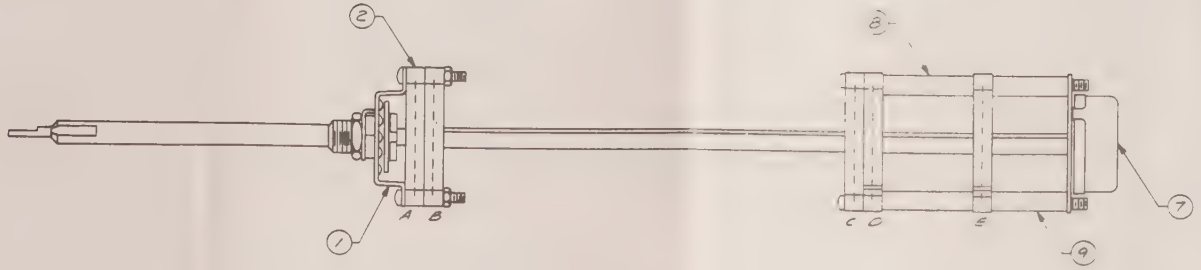
ASSEMBLY NO
1202-00-0015

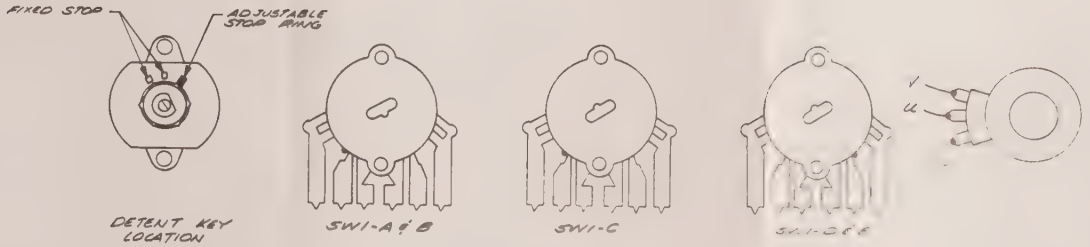
REV
C

SHEET 1

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: TRIGGER SWITCH
	RELEASE APPROV		
Finish WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± XX ± .02		MODEL NO 146 / DWG NO 1202-00-0015 / REV C
	DO NOT SCALE DWG		CODE IDENT 23338 / SHEET 1 OF 1
	SCALE		





NOTES:
1. SWITCH VIEWED FROM KNOB END OF BOARD
2. SWITCH SHOWN IN FULL CCW POSITION

B	345	B+	
A	884	A	

TOLERANCES UNLESS OTHERWISE SPEC: X.X ± .10, X.X ± .020, ANGLES ± 0°30'

WAVETEK SAN DIEGO CALIFORNIA

SCALE –

BY GRAY DATE 9-28-72 APP'D

MATERIAL –

FINISH –

TITLE: SWITCH ASSY FREQ Hz

MODEL NO. 146 DWG NO. 1202-00-0016 REV B

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REV				

REFERENCE DESIGNATORS	PART DESCRIPTION	MFG'S PART NO.	MFGR	WAVETEK NO.	QTY/PC
6	SPACER	142-308	MFTR	1400-00-2073	6
4	SPACER, 3/8"	1406-00-0013	MFTR	1400-00-0013	6
7	PUTTOGNIZER	130-XXX	MFTR	4000-XX-0305	1
2	PAPER	187-BAJ-1	MFTR	5104-00-0013	5
NONE	SMITH DIP	216-33-000	LTS	5104-07-0006	1
1	PCTENT MOD	5104-00-0003	MFTR	5104-00-0003	1

WAVETEK PARTS LIST

TITLE
PREM DR 4551

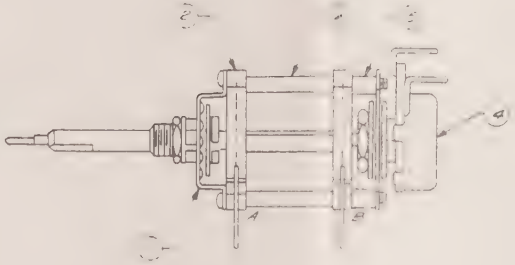
ASSEMBLY NO
1400-00-0018

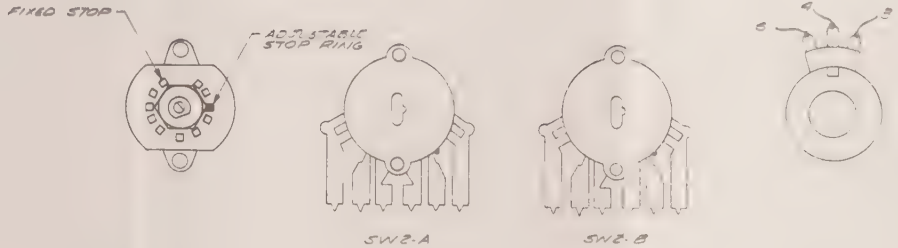
REV
0

PAGE 1

REMOVE ALL BURRS AND BREAK SHARP EDGES	MFG		WAVETEK
MATERIAL	PROJECTOR		
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.02		
	DO NOT SCALE DWG.		
	SCALE		
		23338	SHEET 1

NOTE UNLESS OTHERWISE SPECIFIED





NOTES:
1. SWITCH VIEWED FROM KNOB END OF BOARD
2. SWITCH SHOWN IN FULL CCW POSITION

REV	DESCRIPTION	DATE	APP
A	ECN 24...		

REV	ECN	BY	DATE	APP

TOLERANCE UNLESS OTHERWISE SPEC
X.XX ± .010
X.X ± .030
ANGLES ± 0°30'

WAVETEK SAN DIEGO, CALIFORNIA

SCALE –

BY GRAY DATE 8-20-76 APP

MATERIAL –

FINISH –

TITLE
SWITCH ASSY
ATTENUATOR

MODEL NO. 166

DWG NO. 807.00-0017

REV A

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REFERENCE DESIGNATIONS	PART DESCRIPTION				
3	SPACER				
4	POT,CONTACTOR	13W-M1M	MFR	4805-01-0307	1
1	DETENT	13W-4VC	MFR	5104-01-4003	1
2	WAFER	1W2-3P1-1	MFR	5104-02-0015	2
	SUP	212-33-60A	MFR	5104-01-0100	1

WAVETEK PARTS LIST

TITLE	ASSEMBLY NO	REV
ATTEN SW 8527	1CVE-4G0-0017	A
	PAGE 1	

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS

OTHERWISE SPECIFIED
XXX ± .010 ANGLES ± 1
XX ± .030
DO NOT SCALE DWG

WAVETEK

ATTEN SW

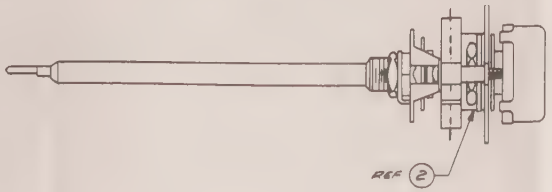
MODEL NO. 4G

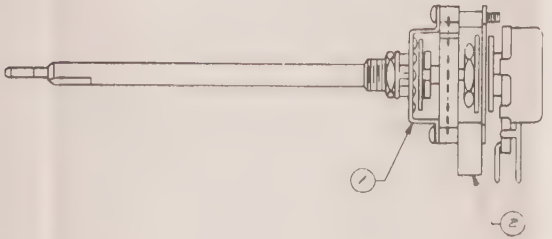
1CVE-4G0-0017

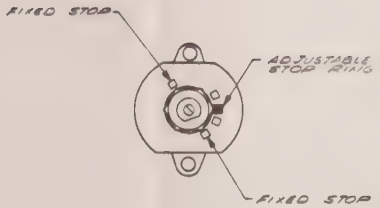
A

23338

PAGE 1







SW2

NOTES:
1. SWITCH VIEWED FROM KNOB END OF BOARD
2. SWITCH SHOWN IN FULL CCW POSITION

REV	DESCRIPTION	DATE	APPROVED
B	975	B- 2/24	
A	ECN 73	5/81	

TOLERANCE UNLESS OTHERWISE SPEC	REV	DESCRIPTION	BY	DATE	APP
XX ± .010					
X ± .030					
ANGLES ± 1° 00'					

WAVETEK SAN DIEGO, CALIFORNIA

SCALE –
BY GMAY DATE 2-27-78 APP

MATERIAL
–

TITLE
SWITCH ASSY
D/C OFFSET

MODEL NO 196
DWG NO 07200-208
REV B

FINISH
–

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REASON EXCEPT CALIBRATION OPERATION AND
MAINTENANCE WITHOUT WRITTEN AUTHORIZATION

WAVETEK
PARTS LIST

TITLE

PAGE 1

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES

MATERIAL

FINISH
WAVETEK PROCESS

PROTRACTOR

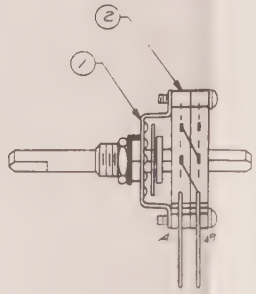
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX .010 ANGLES
XX .030

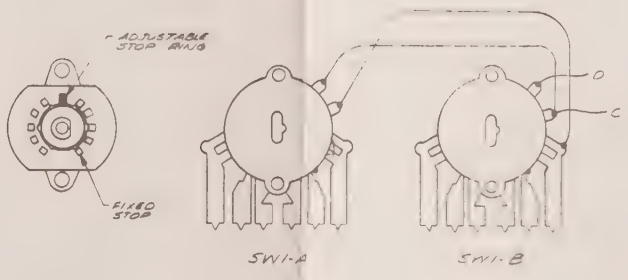
DO NOT SCALE DWG

WAVETEK

MODEL NO

3338





NOTES:

1. SWITCH VIEWED FROM KNOB END OF BOARD
2. SWITCH SHOWN IN FULL CCW POSITION

REV	ECN	BY	DATE	APP

WAVETEK SAN DIEGO CALIFORNIA

TOLERANCE UNLESS OTHERWISE SPEC	XXX ± .010, XX ± .020, ANGLES ± 0° 15'
SCALE –	BY GRAY DATE 9-29-72 APP
MATERIAL –	TITLE SWITCH ASSY FREQ/PERIOD
FINISH –	MODEL NO. 196 DWG NO. 02800-0009 REV B

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REFERENCE DESIGNATIONS	PART DESCRIPTION	UNITS-PER-ASSY-PART-NO	MFGR	WAVETEK NO.	
2	WAFER	115-SM-1	MRIA	5104-02-0018	
NONE	SWITCH STOP	21E-33-006	CTS	5104-07-0002	
1	DETENT,MOD PNUM[5104-01-0003	5104-99-0042	MVTK	5104-99-0042	

WAVETEK PARTS LIST

TITLE: FREQ/PERIOD SW Assy

ASSEMBLY NO: 1202-00-0019

REV:

PAGE: 1

NOTE UNLESS OTHERWISE SPECIFIED

MATERIAL

FINISH: WAVETEK PROCESS

TOLERANCE UNLESS OTHERWISE SPECIFIED: .XXX ±.010 ANGLES ± .5°

DO NOT SCALE DWG

WAVETEK

TITLE: FREQ/PERIOD SW

MODEL NO: 146

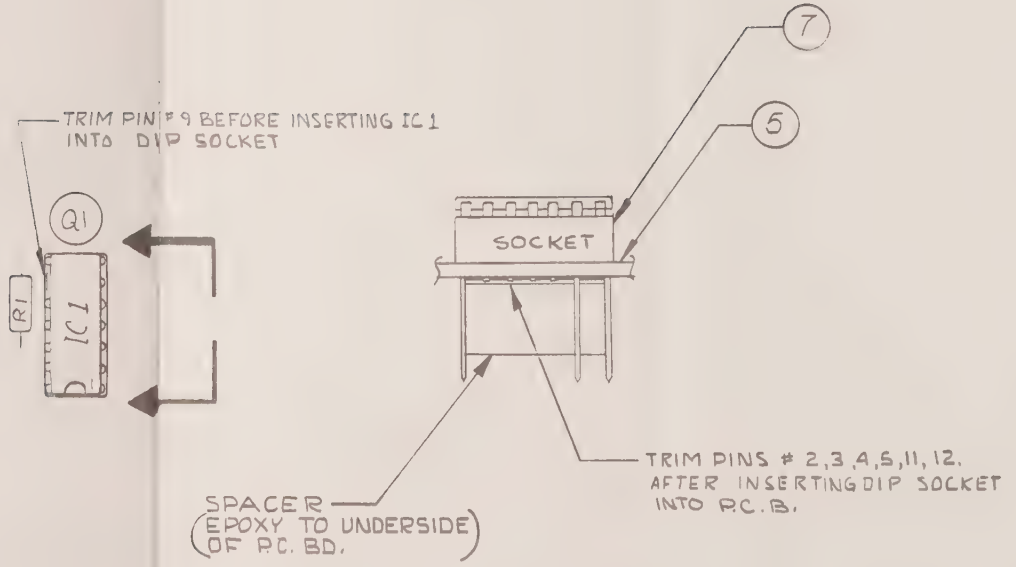
DWG NO: 1202-00-0019

REV: 2

SIZE: B

SHEET 1 OF 1

A	ECN 1472	120	9-28-76



WAVETEK
PATCH BLOCK (MODEL 154)
1205-00-0489 A
B 3-11-76 K.to
SHT. 2 of 2

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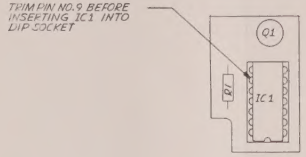
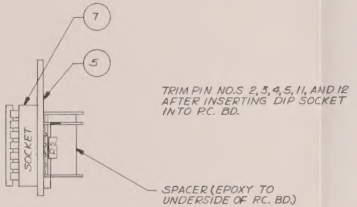
REV	ECN	BY	DATE	APP
A	ECN NO. 1472	RO	9-28-76	
B	REDRAWN (NO CHANGES)	DC	12-5-79	
C	# 1999	DC	7-17-79	





REFERENCE DESIGNATIONS	PART DESCRIPTION	CHTG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
3	SPACER	1400-00-4841	4141	1400-00-4841	1
6	CHIP REPLACEMENT KIT	154-126	4141	1700-00-0869	1
7	SKT,IC,16PIN,WW	CS42200-1446	5A4	2100-03-0002	1
R2	RES,MF,12.4K,1%,1/8W	RN55E-4911F	TRW	0701-0349011	1
R1	RES,PR,17MA,1%,0.25W	WRS60-6991F	TRW	0701-0349981	1
Q1	TRANS	2N5639	CSI	1851-0349638	1
IC1	IC	741S74	FI	1820-1281	1

WAVETEK PARTS LIST

TITLE PATCH PLUG

ASSEMBLY NO. 1205-00-0489

PAGE 1

REV C

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN D. COOPER	DATE 12-5-79	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE PATCH BLOCK
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .020		
	DO NOT SCALE DWG		MODEL NO 144, 146, 154 DWG NO 1205-00-0489 REV C
	SCALE		CODE IDENT 23338 SHEET 2 OF 2

NOTE UNLESS OTHERWISE SPECIFIED

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1030091